DA 16-676
Office of Engineering and Technology, FCC
Technological Advisory Council (TAC)
Noise Floor Technical Inquiry
ET Docket No. 16-191

Catherine Kleiber
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Waterloo, WI 53594

August 5, 2016

Dear Sir or Madam,

Thank you for opening a docket on Incidental and Unintentional Radiators, as well as Unlicensed Intentional Radiators, Industrial, Scientific, and Medical (ISM) Radiators, and Licensed Radiators. Regulation of these devices needs to be tightened substantially. Regulation was originally designed to prevent equipment from interfering with other equipment. We now know that the human body is extremely sensitive to that same interference. **Since the human body cannot be "hardened" to prevent "noise" from affecting it, regulations need to be tightened substantially to make technology safe.** Currently, polluting technology is causing serious health problems.

Inverters

One seriously polluting technology that is making many people sick is the inverter. It is causing serious problems with "dirty" electricity, radiated RF, and ground currents. People are becoming ill when exposed to the "dirty" electricity, radiated RF, and ground currents from their own inverter or from their neighbor's inverter. Industrial inverter installations such as for wind turbines and solar systems often sicken people for miles around. I am attaching several reports showing this problem related to wind turbines. They include:

Wind Turbines Make Waves: Why Some Residents Near Wind Turbines Become Ill
Magda Havas and David Colling
Bulletin of Science Technology & Society
http://bst.sagepub.com/content/early/2011/08/24/0270467611417852

Ground Current Investigation at Denmark, WI Residences David Stetzer, Stetzer Consulting, LLC

Modern Wind Turbines Generate Dangerously "Dirty" Electricity
Catherine Kleiber, Waveforms and picture courtesy of David Colling

Ground Current Investigation, Otho, IA and Pomeroy, IA David Stetzer, Stetzer Consulting, LLC

Dave Colling was seeing the same RF related problems around solar installations which makes sense since they also rely on inverters. Similar problems can be seen with other polluting devices.

It is imperative that noise standards be tightened for inverters and all polluting devices to minimize "dirty" electricity, radiated RF, and ground currents. **New, stricter regulations are needed to protect human health.**

The Stetzerizer "dirty" electricity meter was evaluated in Kazakhstan and health standards were set such that no more than 50 G/S units of dirty electricity should be allowed on building wiring to protect health (www.electricalpollution.com/documents/Sanitary_Norms.pdf) and attached. The FCC should adopt this standard and require inverter manufacturers to engineer their devices to put out substantially less than that. Frequencies above the range of the Stetzerizer meter should also have much tighter standards. Their effect is related to capacitive coupling and energy. New standards should extend the full frequency range of existing and future intentional and unintentional transmitter output and be tight enough to protect human health.

Sincerely,

Catherine Kleiber

CONFIRMED:
The order of the Head State Sanitary Physician of the Republic of Kazakhstan
« _28_ » _ November 2003_г. № 69

Permissible levels of high-frequency electromagnetic pollutions' voltage in a wires of industrial frequency alternating current

Sanitary-epidemiologic norms

1 General provisions

1. Sanitary-and-epidemiologic norms «Permissible levels of high-frequency electromagnetic pollutions' voltage in a wires of industrial frequency alternating current» (further - norms) define levels electromagnetic pollutions in electric wires of power supply of an industrial electric equipment, office techniques, electrical household appliances in a range 1 kiloHertz – 400 kiloHertz (further – kHz).

2. The present norms are directed on improvement and optimization of a sanitary-epidemiologic situation and prevention of environmental contamination by electromagnetic radiation, and also management of corresponding risk, in addition to existing norms.

3. Heads of the organizations and physical persons which activity is connected to operation of the industrial organizations using the equipment and devices, being sources of electromagnetic radiation, provide maintenance of requirements of the present norms.

4. In the present norms the following terms and definitions are used:

1) electromagnetic pollution – parasitic (casual) frequencies in a network of an alternating current of industrial frequency of 50 Hertz (further – Hz) which source is not determined;

2) electromagnetic pollutions – one of kinds of electromagnetic pollution in a range of frequencies 1 kHz – 400 kHz, arising in networks of an alternating current of industrial frequency.

2 Permissible level of electromagnetic pollutions' voltage

5. The permissible level of a high-frequency electromagnetic pollutions' voltage in a range of frequencies 1-400 kHz in a wires of an alternating current of industrial frequency of 50 Hz should not exceed 0,05 volts (further – V) 50 millivolts (further – mV).

3 Choice of points of the control

6. Control points get out in the socket of wires of an alternating current of industrial frequency (50 Hz), taking place near to a plug (socket) of a cable of the connected equipment. The number of control points depends on number of workplaces. In each control point one measurement is carried out.

4 Recommended devices for the control

7. For the control high-frequency electromagnetic pollutions in a range of frequencies (1-400) kHz in a wires of an alternating current of industrial frequency of 50 Hz are recommended to be used millivoltmeter, having corresponding characteristics and registered in the State Register of Republic of Kazakhstan.

5 Requirements to carrying out of measurement

8. The device is plugged into socket of an alternating current in a control point.

9. Tap switch of ranges necessary to put in position of 1-2 V.

10. If indications are not fixed or are small, tap switch put in position 100-999 mV or in position 1,1-99,9 mV, depending on a registered level of a voltage.

Results are registered and compared to the norms specified in item 5 of the present norms.

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Wind Turbines Make Waves: Why Some Residents Near Wind Turbines Become Ill

Magda Havas[1] and David Colling[2]

Abstract

People who live near wind turbines complain of symptoms that include some combination of the following: difficulty sleeping, fatigue, depression, irritability, aggressiveness, cognitive dysfunction, chest pain/pressure, headaches, joint pain, skin irritations, nausea, dizziness, tinnitus, and stress. These symptoms have been attributed to the pressure (sound) waves that wind turbines generate in the form of noise and infrasound. However, wind turbines also generate electromagnetic waves in the form of poor power quality (dirty electricity) and ground current, and these can adversely affect those who are electrically hypersensitive. Indeed, the symptoms mentioned above are consistent with electrohypersensitivity. Sensitivity to both sound and electromagnetic waves differs among individuals and may explain why not everyone in the same home experiences similar effects. Ways to mitigate the adverse health effects of wind turbines are presented.

Keywords

wind turbine, dirty electricity, power quality, ground current, contact current, electrohypersensitivity, noise, infrasound, vibroacoustic disease, wind turbine syndrome

Introduction

With growing concern about climate change, the carbon budget, depletion of fossil fuels, air pollution from dirty coal, radiation from nuclear power plants, and the need for a secure energy supply, more attention and funding are being diverted to renewable energy. Among the various types of renewable energy, wind has received a lot of attention due, in part, to opposition from communities earmarked for wind turbines and from communities that have experienced wind turbines firsthand.

Some people who live near wind turbines report difficulty sleeping and various symptoms of ill health and attribute these problems to noise and shadow flicker—two elements they can perceive. Indeed the U.S. National Research Council (Risser et al., 2007) identify noise and shadow flicker as the two key impacts of wind turbines on human health and well-being.

Not all health agencies, however, recognize that sound waves from wind turbines may cause adverse health effects. Following a review of the literature, the Chief Medical Officer of Health for Ontario (2010), concluded

> that while some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects. The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct health effects, although some people may find it annoying.
>
> Low frequency sound and infrasound from current generation upwind model turbines are well below the pressure sound levels at which known health effects occur. Further, there is no scientific evidence to date that vibration from low frequency wind turbine noise causes adverse health effects.

What specifically is responsible for the illness reported near wind turbines is controversial; while some of this controversy is scientifically valid, some of it is politically motivated (Phillips, 2010).

It is intriguing that not everyone in the same home experiences symptoms, and the symptoms are not necessarily worse for those nearest the turbines. Indeed, the situation may be much more complex than noise and shadow flicker.

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Why do some people who live near wind turbines become sick while others feel no ill effects? What aspects of wind power generation and distribution are responsible for the health problems? What can be done to minimize adverse human biological and health effects? These are some of the questions addressed in this report.

Wind Turbines Make Waves

What aspects of wind power generation and distribution are responsible for the adverse health effects experienced by those who live near wind turbines?

The short answer to this question is that *wind turbines make waves*. They make pressure waves and electromagnetic waves. The pressure waves (or sound waves) generated by the moving turbines can be heard as noise and/or perceived as infrasound. The electromagnetic waves are generated by the conversion of wind energy to electricity. This conversion produces high-frequency transients and harmonics that result in poor power quality. These high frequencies can flow along the wires (dirty electricity) and along the ground, thereby causing ground current. These four types of waves—noise, infrasound, dirty electricity, and ground current—and shadow flicker are each likely to contribute to ill health among those who live near wind turbines.

Characteristics of Sound Waves and Electromagnetic Waves

Sound waves are longitudinal waves that require a medium for transport. They travel at the speed of sound (340 meters/second) through air and are much slower than electromagnetic waves that travel at the speed of light (300,000,000 meters/second) and can travel through a vacuum. Both sound waves and electromagnetic waves have a frequency (cycles per second) and an intensity (amplitude of the wave).

Frequency refers to the number of waves or cycles per second and is known as pitch for sound. The A above middle C, for example, is set to a frequency of 440 cycles per second (hertz, abbreviated as Hz). The audible range for the human ear is between 20 and 20,000 Hz. Frequencies below 20 Hz are referred to as "infrasound," and, although they cannot be heard, they can still have an effect on the body. Infrasound can travel much greater distances than higher frequency sound waves and could potentially reach and affect a much larger population.

The frequencies of electromagnetic waves, generated by wind turbines, fall within two ranges of the electromagnetic spectrum: extremely low frequency (ELF), below 1,000 Hz; and the lower range (kilohertz [kHz] to megahertz [MHz]) of the radio frequency radiation (RFR) band. Electromagnetic waves can enter homes by various paths: through the air, along wires, through the ground, and via plumbing and other metal structures. Electromagnetic waves travelling across the ground contribute to ground current.

Intensity is measured by the amplitude of the wave and, for sound, is measured in decibels (dB). Vibrations with the same frequency but different amplitude will sound the same, but one will be louder than the other. The decibel scale is logarithmic. A quiet bedroom is at 25 dB, conversation is around 60 dB, a rock group is at 110 dB, and the human threshold of pain is at 140 dB.

The intensity of electromagnetic waves is measured in various ways: electric field, magnetic field, voltage, current, and power density. The biological effects of electromagnetic energy are a function of frequency, intensity, and both the manner and the duration of exposure.

Pressure Waves: Noise

Most people who live near wind turbines and complain of ill effects blame the effects on the noise generated by the turbines (Frey & Hadden, 2007).

> Everything changed . . . when the wind turbines arrived . . . approximately 700 metres away from our property . . . Within days of the windfarm coming into operation we began to hear a terrible noise . . . The noise drove us mad. Gave us headaches. Kept us awake at night. Prevented us from having windows and doors open in hot weather, and was extremely disturbing.
>
> This noise is like a washing machine that's gone wrong. It's whooshing, drumming, constant drumming, noise. It is agitating. It is frustrating. It is annoying. It wears you down. You can't sleep at night and you can't concentrate during the day . . . It just goes on and on . . . It's torture . . . [4 years later] You just don't get a full night's sleep and when you drop off it is always disturbed and only like "cat napping." You then get up, tired, agitated and depressed and it makes you short-tempered . . . Our lives are hell.

The French National Academy of Medicine (Chouard, 2006) issued a report that concludes,

> People living near the towers, the heights of which vary from 10 to 100 meters, sometimes complain of functional disturbances similar to those observed in syndromes of chronic sound trauma . . .
>
> The sounds emitted by the blades being low frequency, which therefore travel easily and vary according to the wind . . . constitute a permanent risk for the people exposed to them . . .
>
> . . . sound levels 1 km from an installation occasionally exceeded allowable limits.
>
> . . . the Academy recommends halting wind turbine construction closer than 1.5 km from residences. (Translated from French)

Noise, especially at night, has been associated with an increase in stress hormones leading to hypertension, stroke, heart failure, and immune problems. It is discussed in greater detail elsewhere in this journal.

Pressure Waves: Infrasound

Repetitive noise can be disturbing, especially at night, when sound seems amplified. However, pressure waves at levels outside the range of human hearing can also have unpleasant side effects.

In Nova Scotia, one family was unable to remain in their home and blamed their loss of sleep and headaches on vibrations from 17 turbines (Keller, 2006).

> The d'Entremont family complained of noise and low frequency vibrations in their house after the wind turbines began operation in May 2005. The inaudible noise deprived his family of sleep, gave his children and wife headaches, and "made it impossible for them to concentrate." They now live nearby; if they return to their home, the symptoms return.
>
> Natural Resources Canada, which oversees funding for wind farm projects, found no problems with low-frequency noise or infrasound. The government report concludes that the measurements:
>
> indicate sound at infrasonic frequencies below typical thresholds of perception; infrasound is not an issue. (cited in Frey & Hadden, 2007)

Gordon Whitehead, a retired audiologist with 20 years of experience at Dalhousie University in Halifax, conducted tests and found similar results but came up with a different conclusion:

> They're [Natural Resources Canada] viewing it from the standpoint of an engineer; I'm viewing it from the standpoint of an audiologist who works with ears . . . The report should read that (the sound) is well below the auditory threshold for perception. In other words, it's quiet enough that people would not be able to hear it. But that doesn't mean that people would not be able to perceive it.
>
> " . . . low-frequency noise can affect the balance system of the ear, leading to a range of symptoms including nausea, dizziness and vision problems. It's not perceptible to the ear but it is perceptible. It's perceptible to people with very sensitive balance mechanisms and that's generally people who get very easily seasick.

Resonance may explain why infrasound is harmful at low intensities. Different parts of the human body have different resonance frequencies. When the external frequency generated by a wind turbine approaches the resonance frequency of a part of the human body, that body part will preferentially absorb the energy and begin to vibrate. For example, frequencies that affect the inner ear (between 0.5 and 10 Hz) can interfere with balance, cause dizziness or vertigo, contribute to nausea, and be experienced as tinnitus or ringing in the ears. According to the International Standards Organization (ISO Standards 2631), frequencies for the eye are between 20 and 90 Hz, head 20 and 30 Hz, chest wall 50 and 100 Hz, abdomen 4 and 8 Hz, and spinal column 10 and 12 Hz. Some of the symptoms documented at infrasonic frequencies (between 4 and 20 Hz) include general feeling of discomfort, problems with breathing, abdominal and chest pain, urge to urinate, lump in throat, effect on speech, and head symptoms (Frey & Hadden, 2007).

According to a report by the U.S. Air Force, Institute for National Security Studies, acoustic infrasound can have dramatic and serious effects on human physiology (Bunker, 1997).

> Acoustic, infrasound: very low frequency sound which can travel long distances and easily penetrate most buildings and vehicles. Transmission of long wavelength sound creates biophysical effects, nausea, loss of bowels, disorientation, vomiting, potential organ damage or death may occur. Superior to ultrasound because it is "inband," meaning it does not lose its properties when it changes mediums such as air to tissue. By 1972 an infrasound generator had been built in France, which generated waves at 7Hz. When activated it made the people in range sick for hours.

In a paper known as "The Darmstadt Manifesto," published in September 1998 by the German Academic Initiative Group and endorsed by more than 100 university professors in Germany, the German experience with wind turbines is described as follows (cited in Frey & Hadden, 2007):

> More and more people are describing their lives as unbearable when they are directly exposed to the acoustic and optical effects of wind farms. There are reports of people being signed off sick and unfit for work, there is a growing number of complaints about symptoms such as pulse irregularities and states of anxiety, which are known to be from the effects of infrasound [sound frequencies below the normal audible limit].

Infrasound is influenced by topography, distance, and wind direction (Rogers, Manwell, & Wright, 2006) and differs from home to home and room to room because each room is a distinct cavity with its own resonant frequency. Whether a door is open or closed can alter the effect.

The biological effects of low-frequency noise (20-100 Hz) and infrasound (less than 20 Hz) are a function of intensity, frequency, duration of exposure, and direction of the vibration.

Wind Turbine Syndrome and Vibroacoustic Disease

Exposure to low-frequency noise and infrasound may produce a set of symptoms that include depression, irritability, aggressiveness, cognitive dysfunction, sleep disorder, fatigue, chest pain/pressure, headaches, joint pain, nausea, dizziness, vertigo, tinnitus, stress, heart palpitations, and other symptoms. Not everyone has the same sensitivity. Those who experience motion sickness (car, boat, plane), get dizzy or nauseous on carnival rides, have migraine headaches, or have eye or ear problems may be particularly susceptible to low-frequency vibrations.

Two different "diseases" have been associated with low-frequency noise exposure and infrasound. They are wind turbine syndrome—coined by Pierpont (2009) in her book by the same name—and vibroacoustic disease (VAD). VAD is a whole-body, systemic pathology characterized by the abnormal proliferation of extracellular matrices and caused by excessive exposure to low-frequency noise (Castelo Branco & Alves-Pereira, 2004). These two "diseases" differ as described by Pierpont (2009).

> Wind Turbine Syndrome, I propose, is mediated by the vestibular system—by disturbed sensory input to eyes, inner ears, and stretch and pressure receptors in a variety of body locations. These feed back neurologically onto a person's sense of position and motion in space, which is in turn connected in multiple ways to brain functions as disparate as spatial memory and anxiety. Several lines of evidence suggest that the amplitude (power or intensity) of low frequency noise and vibration needed to create these effects may be even lower than the auditory threshold at the same low frequencies.
>
> Vibroacoustic Disease, on the other hand, is hypothesized to be caused by direct tissue damage to a variety of organs, creating thickening of supporting structures and other pathological changes. The suspected agent is high amplitude (high power or intensity) low frequency noise. (p. 13)

VAD seems to be dose dependent, with symptoms becoming progressively worse with continued exposure. Three stages have been identified based on 70 aircraft technicians who, presumably, were exposed to much higher intensities of low-frequency noise than those who live near wind turbines (Castelo Branco, 1999, Castelo Branco & Alves-Pereira, 2004).

Stage 1: Mild, 1 to 4 years, slight mood swings, indigestion, heartburn, mouth/throat infections, bronchitis

Stage 2: Moderate, 4 to 10 years, depression, aggressiveness, pericardial thickening, light to moderate hearing impairment, chest pain, definite mood swings, back pain, fatigue, skin infections (fungal, viral, parasitic), inflammation of stomach lining, pain during urination, blood in urine, conjunctivitis, allergies

Stage 3: Severe, more than 10 years, myocardial infarction, stroke, malignancy, epilepsy, psychiatric disturbances, hemorrhages (nasal, digestive, conjunctive mucosa), varicose veins, hemorrhoids, duodenal ulcers, colitis, decrease in visual acuity, headaches, severe joint pain, intense muscular pain, neurological disturbances

Whatever name is given to the symptoms, the symptoms are real and can be caused by low-frequency sound waves and infrasound.

Electromagnetic Waves

One undesirable consequence of wind-generated electricity is poor power quality due to variable weather conditions, mechanical construction of the towers, and the electronic equipment used (Lobos, Rezmer, Sikorski, & Waclawek, 2008). Electricity in North America has a frequency of 60 Hz and is a sine wave when viewed on an oscilloscope (Figure 1). When a wind turbine generates electricity, the frequency must be converted to 60 Hz by power converters; that conversion generates a large spectrum of current and voltage oscillations leading to poor power quality (Lobos et al., 2008). Wind turbines can generate a wide range of frequencies—from less than 1 Hz (Lobos et al., 2008), with the majority of the frequencies in the kHz range associated with power conversion.

Dirty Electricity

High-frequency transient spikes that contribute to poor power quality, also known as dirty electricity, can flow along wires, damage sensitive electronic equipment, and adversely affect human and animal health.

After wind turbines were activated in Ripley, Ontario, several of the residents complained of ill health. Residents suffered from headaches, poor sleep, elevated blood pressure (requiring medication), heart palpitations, itching, ringing and pain in the ears, watering eyes, and pressure on the chest causing difficulty breathing. These symptoms disappear when the residents leave the area. Some residents were forced to move out of their homes because the symptoms were so severe. Locals complain of headaches and poor radio reception when they drive near these power lines.

One of the authors (DC) measured the power quality near several residences where people were unwell. The primary neutral-to-earth voltage (PNEV) is the electrical potential difference between the earth and the neutral wire on the primary distribution line, as shown in Figure 2. Measurements taken before wind turbines were installed and after they were installed and operating (Figure 3) clearly show the distortion (spikes on the waveform) generated by the wind turbines.

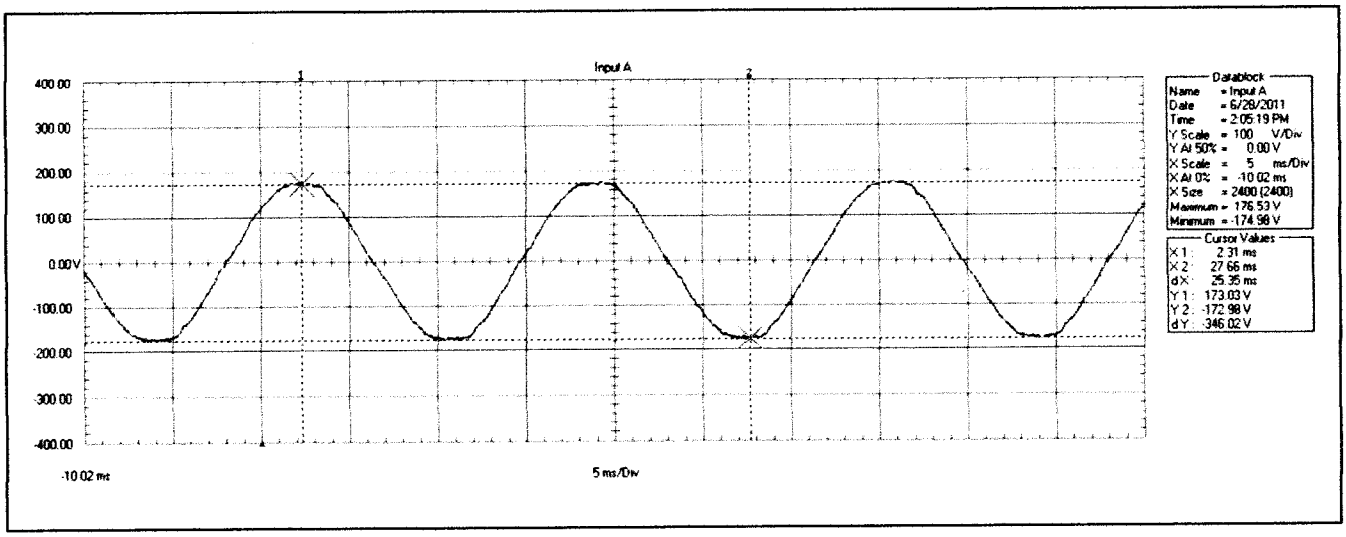

Figure 1. Good power quality exemplified by the 60-Hz sine wave

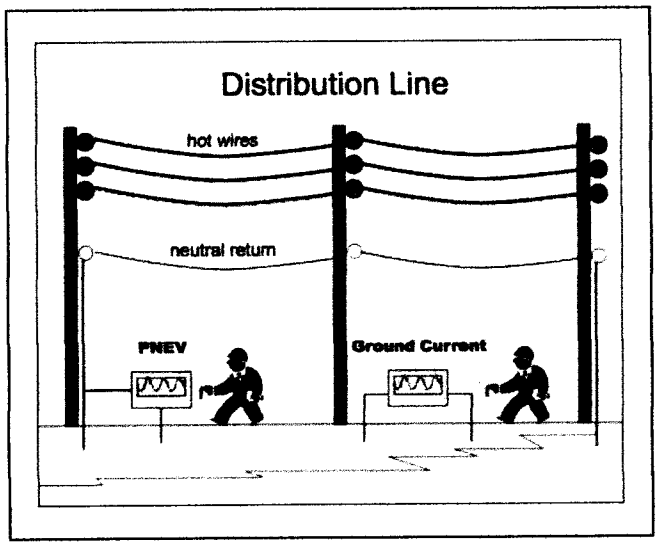

Figure 2. Diagram demonstrating how primary neutral-to-earth voltage (PNEV) and ground voltage measurements are taken

In this area, wind turbines are variable speed and are interconnected. The collection lines connecting the wind turbines to the substation are attached to the same utility pole as the home owners' lines.

According to one of the authors (DC; September 30, 2008),

> We had four families move out of their homes and now if I spend too much time in these homes I get the same symptoms, which is ear aches, ringing in the ears and pressure in the ears. [name removed] eventually buried a portion of the line but have only isolated the lines by insulators so it is better, however there is still some high frequency coming into the houses. The three families that now have buried lines are back in their homes, but things are far from ideal.

Dirty electricity in the kHz range affects human health; this has been shown in schools and homes in both Canada and the United States. Power quality can be improved both on electrical wires by using power line filters (Ontario Hydro, 1998) and inside buildings by using special surge suppressors or power filters that dampen the voltage spikes (http://www.stetzerelectric.com).

In one Wisconsin School that had "sick building syndrome," once power quality was improved, the health of both teachers' and students' improved. According to the school nurse, both staff and students have more energy, fewer allergies, and fewer migraine headaches, and asthmatics rely less on their inhalers (Havas, 2006a).

In a Toronto School, improvements in power quality were accompanied by improvements in teachers' health and students' behavior. Teachers were less tired, less frustrated, less irritable; they had better health and more energy; they had a greater sense of satisfaction and accomplishment; they were more focused and experienced less pain. Students' behavior also improved especially in the elementary grades (Havas, Illiatovitch, & Proctor, 2004). Similar results were reported in a placebo-blinded study in three Minnesota schools (Havas & Olstad, 2008).

Dirty electricity has been associated with increased risk of various types of cancers among teachers in a California school (Milham & Morgan, 2008), with higher blood sugar levels among diabetics, and with exacerbation of tremors and difficulty walking among those with multiple sclerosis (Havas, 2006b). People who are adversely affected by dirty electricity are classified as electrically hypersensitive.

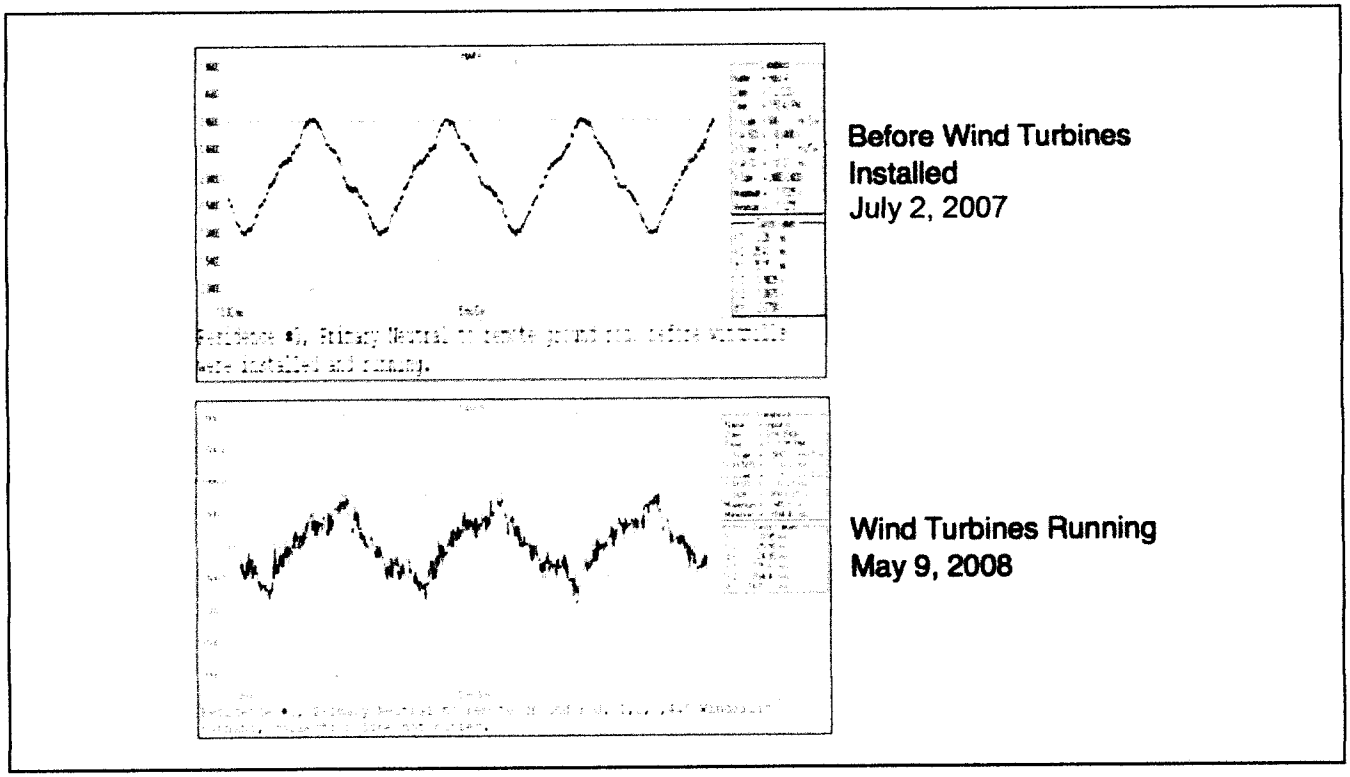

Figure 3. Primary neutral-to-earth voltage (PNEV) at Residence No. 3 in Ripley, Ontario, before wind turbines were installed (July 2, 2007) and when five wind turbines were operating (May 9, 2008)
Note. Collection line was not buried.

Ground Current

Just as dirty electricity can flow along wires, it can also flow along the ground resulting in ground current. Ground current (often measured as voltage and called stray voltage or tingle voltage) is a serious problem in certain locations and has been shown to adversely affect the health of farm families and the health and productivity of farm animals, especially dairy cattle.

The Ontario Federation of Agriculture (2007) provides information on symptoms experienced by farm animals, pets, and people who are exposed to tingle voltage as follows:

> Farmers and their families who suffer from immune disorders such as allergies or rheumatoid arthritis find their symptoms worsen or go into remission in close coordination with livestock symptoms. Periods of fatigue increase. Sleep disorders may increase.
>
> Cats leave the farm, become ill, cease to bear litters or have small, unhealthy litters, or die; coats are usually dull and shaggy and eyes are runny.
>
> Horses may paw the ground and shy away from watering or feeding troughs; behaviour and handling becomes more difficult.
>
> Pigs often take to ear and tail biting; mastitis and baby pig scours are common; piglet mortality may increase.
>
> Cattle lap water from the trough or bowl; feed in the bottom of the manger is not cleaned up; milk out is slow and uneven; cows are reluctant to enter the milk parlour and quick to leave; slow growth in calves and heifers; somatic cell counts are high; unexplained spontaneous abortions of calves; bulls become markedly more irritable.

According to the *National Electrical Safety Code (NESC) Handbook* (Clapp, 1997),

> When the earth returns were used in some rural areas prior to the 1960's, they became notorious offenders in dairy areas because circulating currents often cause both step and touch potentials.
>
> In some cases, they have adversely affected milking operations by shocking the cattle when they were connected to the milking machines, and have affected feeding. (p. 152)

According to Lefcourt (1991) in the U.S. Department of Agriculture book titled *Effects of Electrical Voltage/Current on Farm Animals: How to Detect and Remedy Problems*:

> The effect of a transient voltage superimposed on the regular power voltage (dc or ac) is to cause a momentary

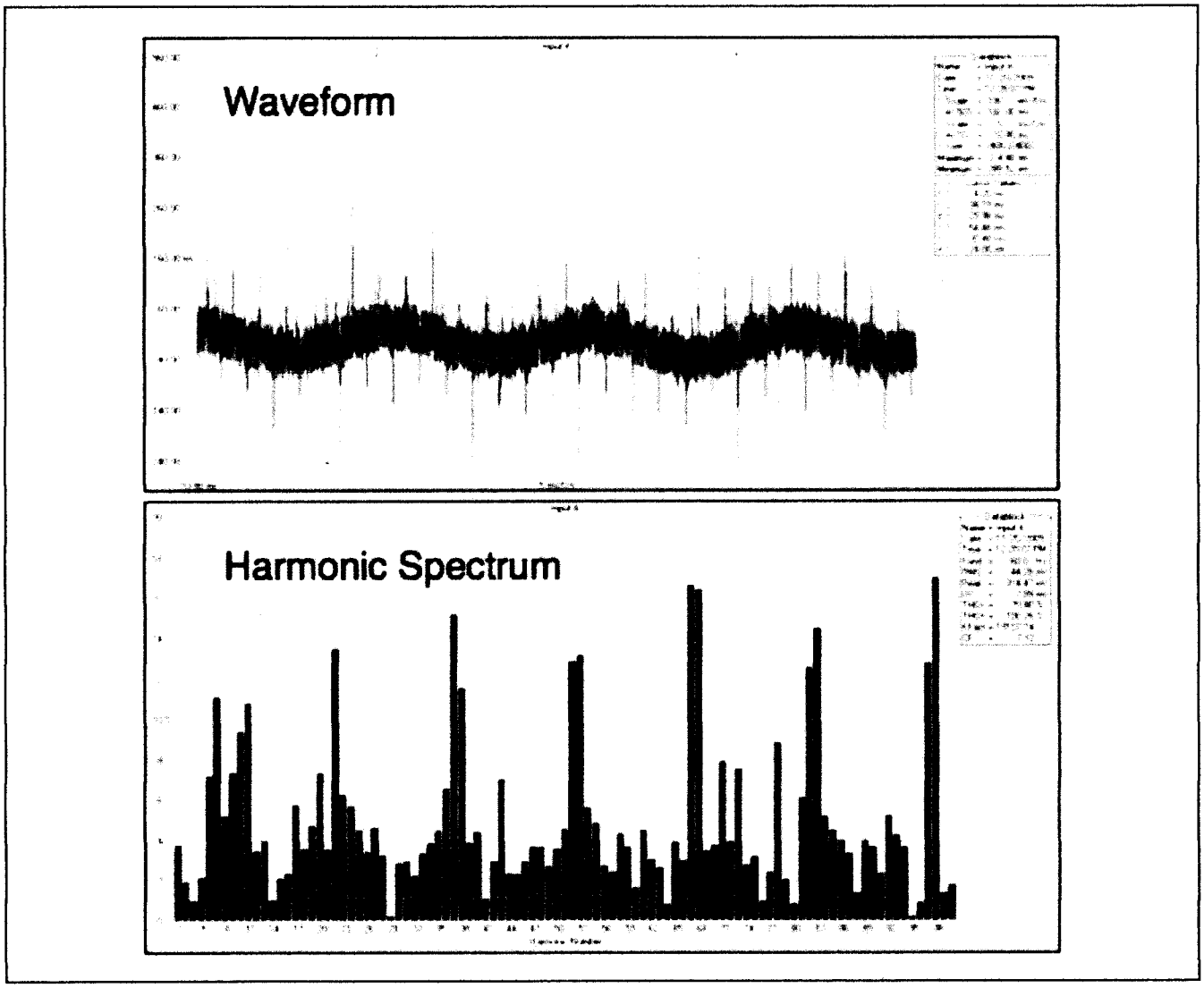

Figure 4. Ground voltage measured at the Palm Springs wind farm in California using 50 feet of copper wire attached to two metal rods in the earth

Note. The top graph shows the distorted 60-Hz waveform, and the bottom graph shows the harmonic frequencies. Data courtesy of Dr. Sam Milham.

> change in the waveform. When the transient causes the momentary voltage to be greater than normal, it may cause a transient current to flow in an animal. If the transient waveform has sufficient energy (magnitude and duration), there may be an animal response. (p. 63-64)

Indeed, dirty electricity flowing along the ground may be more harmful to farm animals than the 60-Hz ground current (Hillman et al., 2003):

> Cows were sensitive to harmonic distortions of step-potential voltage, suggesting that utility compliance with IEEE standards on dairy farms may need to be addressed.
>
> Power quality varied greatly from farm to farm and day to day. Milk production responses to changes in power quality varied inversely with the number of transient events recorded with event recorders, oscilloscope, and power quality meters. Harmonics often gave better estimates of electrical effects on milk production than voltage *per se*. (p. 19)

Do wind turbines generate ground current? They can if proper safeguards are not taken. Generally, this is a problem with power distribution once the energy leaves the turbine.

Figure 4 shows the waveform of ground voltage near an industrial wind farm in Palm Springs, California (as shown in Figure 5 photographs). The waveform distortion in Figure 3 and 4 are considerable when compared with Figure 1.

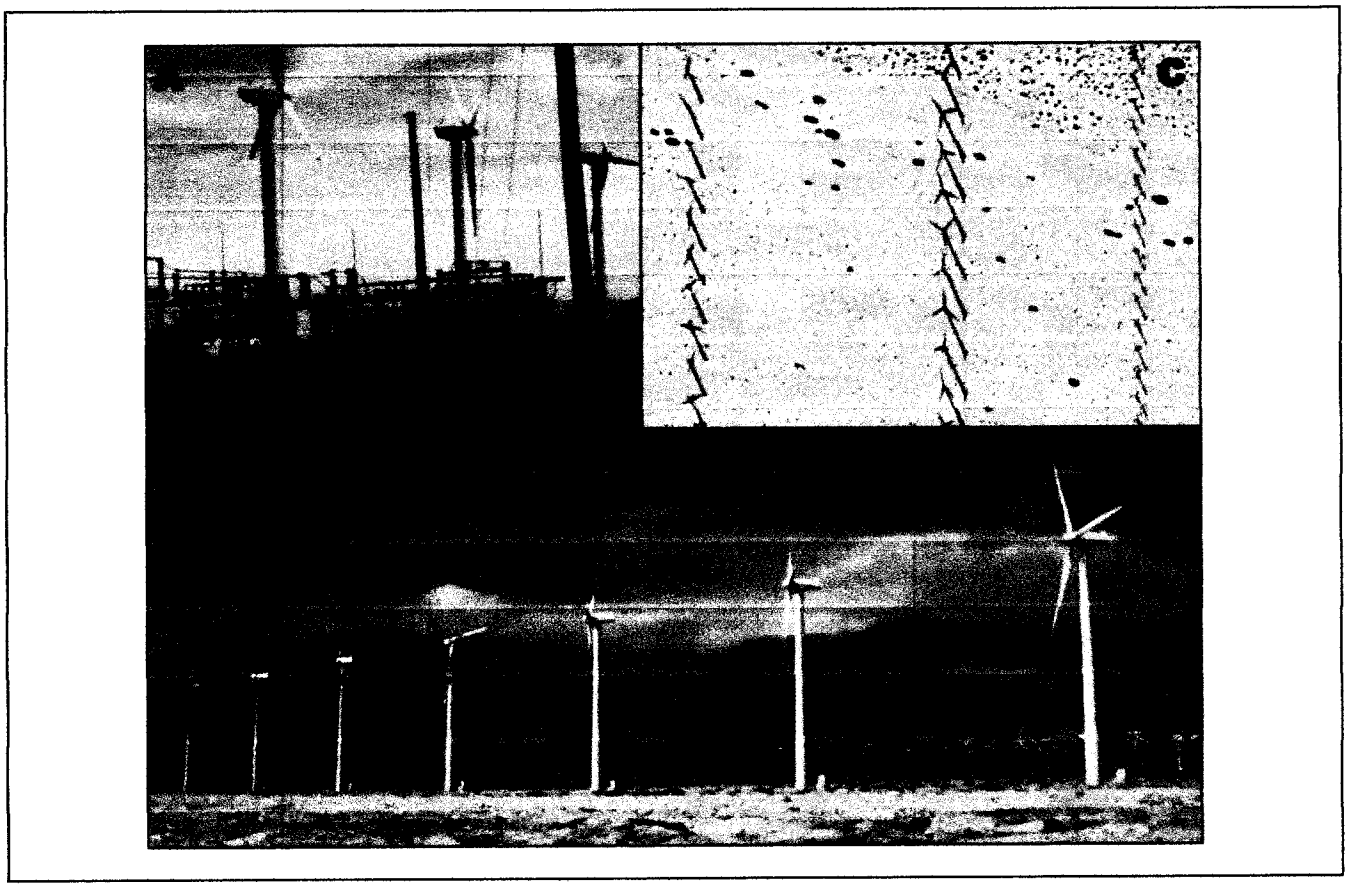

Figure 5. Wind farm in Palm Springs, California, showing (A) location of ground voltage readings; (B), view of wind turbines from the ground; and (C) view of wind turbines from the air
Note. Photograph A from Dr. Sam Milham. Photographs B and C from Google maps.

Burying the collection line may not eliminate the ground voltage but can improve power quality, as shown in Figure 6.

Just as animals are adversely affected by dirty ground current, so are people. If ground current enters a home via the plumbing, touching any part of the plumbing (e.g., faucet) induces a current in the body, known as contact current.

In one Ripley home, the frequency fingerprint (relative intensities of various frequencies) on the plumbing (sink to floor measurement) was similar to the PNEV, indicating that the source of the ground voltage was the wind turbines' collection line (Figure 7). In this home, the sink to floor contact current was calculated to be 400 microamperes (peak to peak based on 200 millivolts and 500 ohms), and this value is 22 times higher than levels associated with cancer according to Kavet, Zaffanella, Daigle, and Ebi (2000).

> "The absolute (as well as modest) level of contact current modeled (18 micro Amps) produces average electric fields in tissue along its path that exceed 1 mV/m. At and above this level, the NIEHS Working Group [1998] accepts that biological effects relevant to cancer have been reported in "numerous well-programmed studies." (p. 547)

Wertheimer, Savitz, and Leeper (1995) documented the link between ground current and cancer in Denver, Colorado. They found that leukemia risk increased by 300% among children exposed to elevated magnetic field from ground current that enters the home through conductive plumbing.

Electrohypersensitivity (EHS)

Why do some people who live near wind turbines become sick while others feel no ill effects?

Exposure to both pressure waves and electromagnetic waves is highly variable—spatially and temporally—as is sensitivity to these vibrations. Not everyone in the same home is going to have the same exposure or the same sensitivity. People who have balance problems, experience motion sickness, or have ear or eye problems are more likely to react to low-frequency sound vibrations. Those who are electrically hypersensitive are more likely to suffer from dirty electricity

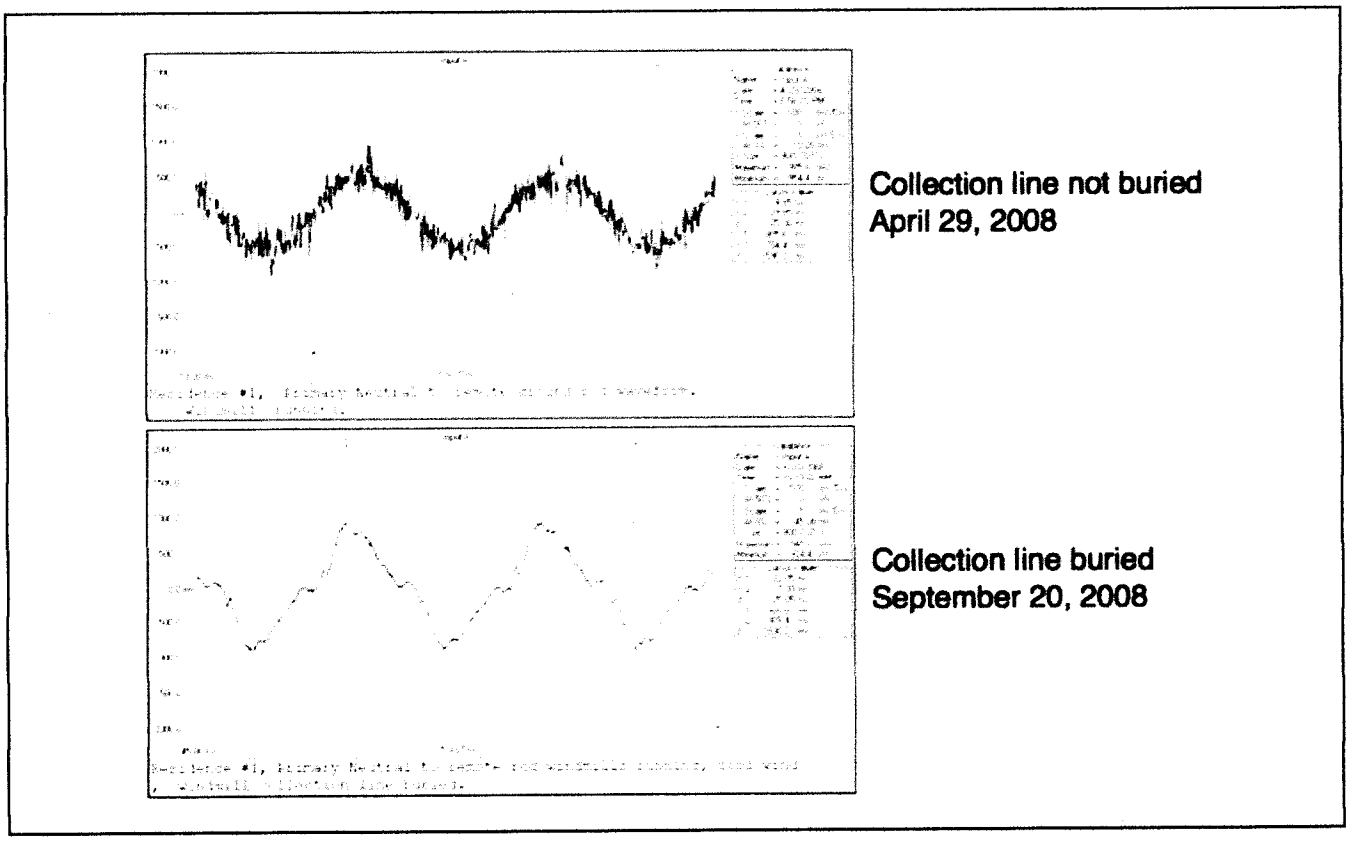

Figure 6. Primary neutral-to-earth voltage (PNEV) at Residence 1 in Ripley, Ontario, when wind turbines were operating
Note. Collection line from wind turbines was buried on September 20, 2008 (bottom graph), but not on April 29, 2008 (top graph).

and contact current. As a result, people living in the same home may have very different sensitivities and may respond differently to these vibrations.

At the Working Group meeting on EMF Hypersensitivity in Prague, the World Health Organization (2004) described electrosensitivity as

> a phenomenon where individuals experience adverse health effects while using or being in the vicinity of devices emanating electric, magnetic, or electromagnetic fields (EMFs).
>
> Whatever its cause, EHS is a real and sometimes a debilitating problem for the affected persons, while the level of EMF in their neighborhood is no greater than is encountered in normal living environments. Their exposures are generally several orders of magnitude under the limits in internationally accepted standards.

Symptoms include cognitive dysfunction (memory, concentration, problem solving); fatigue and poor sleep; body aches and headaches; mood disorders (depression, anxiety, irritability, frustration, temper); nausea; problems with balance, dizziness, and vertigo; facial flushing, skin irritations, and skin rashes; chest pressure, rapid heart rate, and altered blood pressure; ringing in the ear (tinnitus); and nosebleeds. A comprehensive list of the symptoms is provided in Table 1.

In Sweden, EHS is recognized as a functional impairment (not as a disease). Between 230,000 and 290,000 Swedes (about 3% of the Swedish population) may be electrohypersensitive (Johansson, 2006). The number of people complaining of EHS seems to be increasing as is the medication sold to deal with the symptoms of insomnia, pain, fatigue, depression, and anxiety. By 2017, as many as 50% of the population may experience these symptoms (Hallberg & Oberfeld, 2006).

Some individuals may have a predisposition to EHS. Those who have experienced physical trauma to their nervous system (whiplash), electrical trauma in the form of multiple shocks or several severe shocks, and/or chemical exposure to mercury or pesticides are likely to be more electrically sensitive. Children, the elderly, and those with impaired immune systems are also likely to be more electrically sensitive.

It is not possible to determine which factors are contributing to ill health until appropriate monitoring is conducted and steps are taken to reduce exposure to the offending agents. Monitoring of both electromagnetic waves and pressure waves in homes where people report ill health is highly recommended as are the mitigation techniques mentioned below

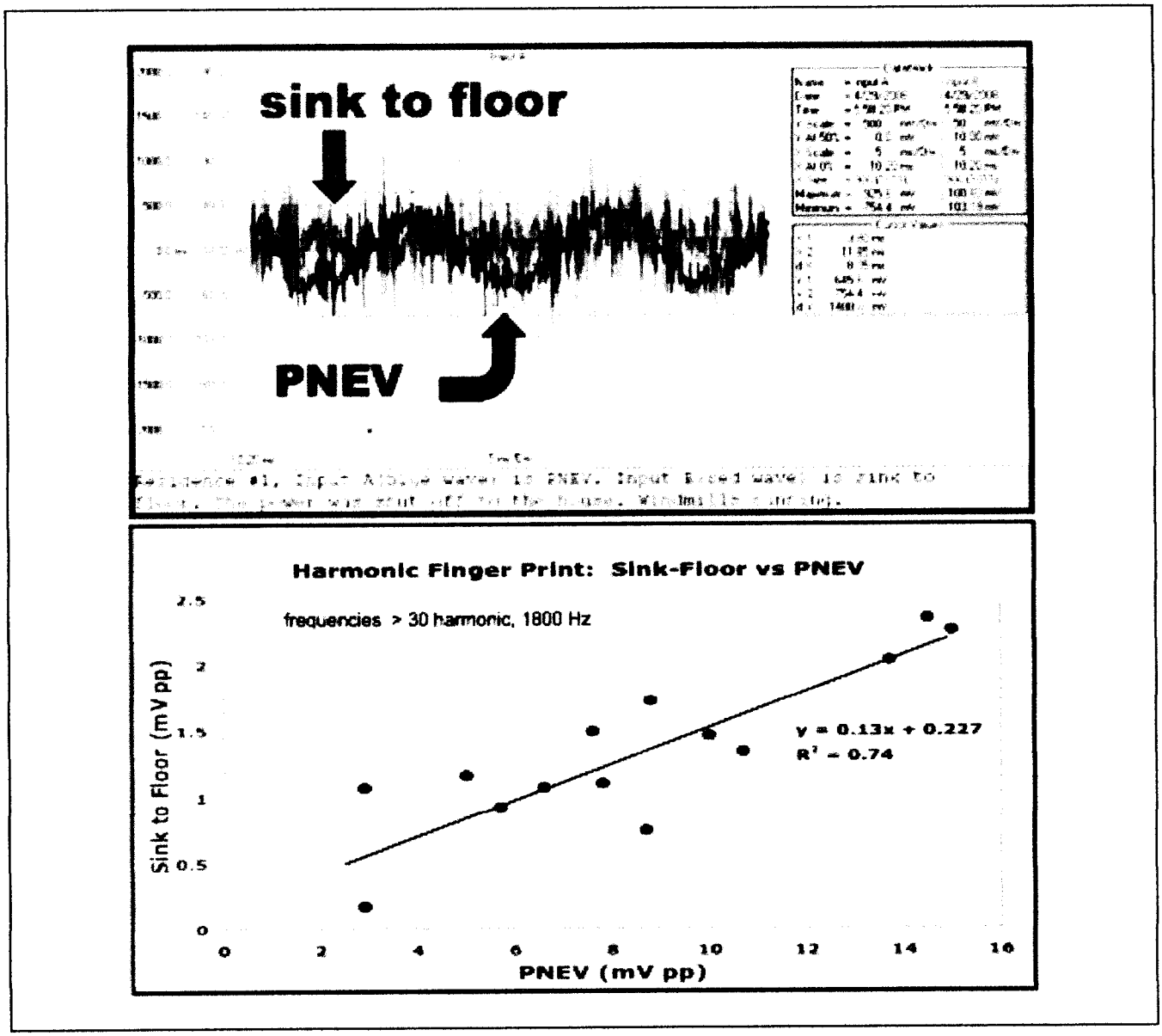

Figure 7. The primary neutral-to-earth voltage (PNEV) and the sink-to-floor voltage for Residence 1 in Ripley, Ontario (top graph), and the harmonic figure print for these voltages (bottom graph).

Recommendations

What can be done to minimize adverse biological and health effects for those living near wind turbines?

One obvious step is to eliminate or reduce exposure to the agent(s) causing the illness.

1. To minimize noise and exposure to infrasound, the following steps should be taken:
   a. Wind turbines should be placed as far away as possible from residential areas. The French National Academy of Medicine (Chouard, 2006) recommends 1.5 km from residential areas.
   b. Buffers can be constructed to disrupt pressure waves and to absorb or deflect sound waves in areas where turbines are closer to homes or where problems have been documented,
2. To improve power quality, the following steps should be taken:
   a. The electricity should be "filtered" at all inverters before it leaves the wind turbine. Ontario Hydro (1998) provides information on power line filters and other ways to improve power quality.
   b. The collector lines from the wind turbines should be attached to utility poles that do not provide power to homes.
   c. Power from the substation supplied by the wind turbines should be filtered before it is distributed to customers.

Table 1. Comprehensive List of Electrohypersensitivity (EHS) Symptoms (Bevington, 2010)

Auditory	Dermatological	Musculoskeletal	Ophthalmologic
earaches, imbalance, lowered auditory threshold, tinnitus	brown 'sun spots', crawling sensations, dry skin, facial flushing, growths & lumps, insect bites & stings, severe acne, skin irritation, skin rashes, skin tingling, swelling of face/neck	aches / numbness pain / prickling sensations in: bones, joints & muscles in: ankles, arms, feet legs, neck, shoulders, wrists, elbows, pelvis, hips, lower back, cramp / tension in: arms, legs, toes, muscle spasms, muscular paralysis, muscular weakness, pain in lips, jaws, teeth with amalgam fillings, restless legs, tremor & shaking	eyelid tremors/'tics', impaired vision, irritating sensation, pain / 'gritty' feeling, pressure behind eyes, shiny eyes, smarting, dry eyes
Cardiovascular altered heart rate, chest pains, cold extremities especially hands & feet, heart arrhythmias, internal bleeding, lowered/raised blood pressure, nosebleeds, shortness of breath, thrombosis effects	**Emotional** anger, anxiety attacks, crying, depression, feeling out of control, irritability, logorrhoea, mood swings,	**Neurological** faintness, dizziness, 'flu-like symptoms, headaches, hyperactivity, nausea, numbness, sleep problems, tiredness	**Other Physiological** abnormal menstruation, brittle nails, hair loss, itchy scalp, metal redistribution, thirst / dryness of lips, tongue, eyes
Cognitive confusion, difficulty in learning new things, lack of concentration, short / long-term memory impairment, spatial disorientation	**Gastrointestinal** altered appetite, digestive problems, flatulence, food intolerances Genito-urinary smelly sweat / urine, urinary urgency, bowel urgency		**Respiratory** asthma, bronchitis, cough /throat irritation, pneumonia, sinusitis **Sensitisation** allergies, chemical sensitivity, light sensitivity, noise sensitivity, smell sensitivity

d. Wind power electrical substations that require power from an external source (electrical distribution network) must ensure that the power quality of this eternal source is not affected as this can result in power quality problems for customers connected to the same external power source.
e. Nearby home owners may need to install power line filters in their homes if levels of dirty electricity remain high.

3. To reduce ground current/voltage, the following steps should be taken:
   a A proper neutral system (possibly a five-wire system) should be installed to handle the high-frequency return current in overhead lines (Electric Power Research Institute, 1995).
   b. Insulators can be placed between the neutral line and the grounding grid for the wind turbine.
   c. The collection lines from the wind turbine to the substation should be buried if the other techniques to minimize dirty ground current are ineffective.
   d. Local home owners may need to install stray voltage isolators near their transformers until the electric utility can resolve the problem (Hydro One, 2007).

If these steps are taken, improved quality of life and a feeling of wellness may return to some of the people adversely affected by nearby wind turbines.

Conclusions

A subset of the population living near wind turbines is experiencing symptoms of ill health. These symptoms are likely caused by a combination of noise, infrasound, dirty electricity, ground current, and shadow flicker. These frequencies can be highly viable spatially and temporally and are affected by distance; terrain; wind speed and direction; shape, size, and type of dwelling; type of power converters used; state of the electrical distribution line; type and number of grounding systems; and even the type of plumbing in homes. Furthermore, not everyone has the same sensitivity to sound and electromagnetic radiation nor do they have the

same symptoms. The following symptoms seem to be quite common: sleeplessness, fatigue, pain, dizziness, nausea, mood disorders, cognitive difficulties, skin irritations, and tinnitus. To help alleviate symptoms in areas where wind turbines have been erected, remediation is necessary to reduce or eliminate both sound waves and electromagnetic waves. More research is required to help us better understand the relative importance of the various factors contributing to poor health. This type of information will enable a healthy coexistence between wind turbines and the people living nearby.

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Bios

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David Colling has applied his electrical engineering studies at Ryerson Polytechnical Institute and his specialized training in electrical pollution to conduct electrical pollution testing for Bio-Ag on farms, homes, and office buildings. Some of the homes tested are located in the environs of industrial wind turbines.

Ground Current Investigation at Denmark, WI Residences

David Stetzer

Stetzer Consulting, LLC

Introduction

In October 2011, I was contacted by Jerome Hlinak of BCCRWE to investigate the possibility of a wind farm near Denmark, WI contributing to a "stray voltage"[1] problem affecting the health of area residents. I was informed that at least two families had moved out of their homes because they could no longer cope with the health problems they associated with their homes' electrical environments. In October 2011, I agreed to go to Denmark, WI and take measurements at several area homes.

This report, resulting from my work near Denmark, WI will provide 1) a brief history regarding the issue of ground currents/voltages, 2) information from published research on ground currents/voltages, and 3) data collected during my testing at area homes showing that a high frequency ground current/voltage issue is present.

History

In 1972 there was an oil embargo that forced countries to become more energy efficient. Energy efficient lightning, variable speed frequency drives, electronic motor starters, light dimmer switches, as well as a host of other electronic loads were rapidly being connected to the electrical grid. These devices use current in short pulses that create harmonics and high frequencies transients on the electrical circuits. Prior to this time the majority of the loads were linear loads. With Linear loads the current was drawn in a continuous manner. The electrical grid was designed for only 60-cycle linear loads like light bulbs and motors and not for the high frequency producing electronic loads that were being added rapidly after 1972. Most electric utilities have not updated their obsolete lines to handle the technological load that started being connected to their system in the late 70's and continues to date. The electric utility's primary neutral wire that was designed to bring the unbalanced current back to the substations was, and still is, no longer capable of handling the excess current and higher than 60-cycle currents now riding on the wire. The wire has too much impedance (opposition to AC current) due to its inadequate size, which causes overheating and a buildup of voltage on the wire called Primary Neutral to Earth Voltage (PNEV). The Institute of Electrical and Electronics Engineers (IEEE) recognized the problems caused by these changing loads and adopted a national standard, the IEEE-519, in 1981. The IEEE revised the standard in 1986, and again in 1992. It was a problem that was recognized and addressed by industry worldwide, except for most electric utilities. It became the topic of most power quality magazines and publications throughout the industry. For example, in the June 1999 issue of Electrical Construction and Maintenance (EC&M) Magazine, Ken Michaels wrote, "Harmonics: It surfaced as a buzzword in the early 1980's, ...".

From the IEEE (1996) *Guide for Applying Harmonic Limits on Power Systems*:

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[1] The term "stray voltage" was coined by electric utilities and public utilities commissions. The word "stray" infers that no one is responsible. There may be stray dogs and stray cats; it may be unknown where they come from or where they are going. Voltage, on the other hand, does not stray; it is governed by scientific laws (Ohm's Law, Kirchhoff's Law, etc.) and it goes where people put it. Therefore, in this report we will refer to this problem as ground currents/voltages, and not "stray voltage".

When single phase electronic loads are supplied with a 3-phase, 4-wire circuit, there is a concern for the current magnitudes in the neutral conductor. Neutral current loading in the 3-phase circuits with linear loads is simply a function of the load balance among the three phases. With relatively balanced circuits, the neutral current magnitude is quite small. This has resulted in a practice of under sizing the neutral conductor in relation to the phase conductors.

With electronic loads supplied by switch-mode power supplies, the harmonic components in the load currents can result in much higher neutral current magnitudes. This is because the odd triplen harmonics (3, 9, 15, etc.) produced by these loads show up as zero sequence components for balanced circuits. Instead of canceling in the neutral (as is the case with positive and negative sequence components), zero sequence components add together in the neutral conductor. The third harmonic is usually the largest single harmonic component in single phase power supplies or electronic ballasts. (p. 63)

Glen A. Mazur, in his 1992 technical manual *Power Quality Measurement and Troubleshooting*, stated:

Triplen harmonics do not cancel, but add together in the neutral conductor. In systems with many 1-phase nonlinear loads, neutral current can exceed an individual phase current. Generally, the amount of neutral current is between 125% and 225% of the highest phase current. The third harmonic current is usually responsible for most of the neutral current because the third harmonic typically represents the harmonic with the highest current value. High neutral current is dangerous because it causes overheating in the neutral. Because there is no CB in the neutral conductor to limit current, as in the phase conductors (A, B, and C), overheating of the neutral can become a fire hazard.

Because of the increased and higher frequency currents on the utilities' primary neutral, the electric utilities decided to use the earth as a return path to their substations for the excess currents they are responsible for. Once the currents are in the earth, they flow uncontrolled over the surface, across private property, into homes and barns, and through humans and animals. This was done despite national standards and electrical safety codes, as evidenced in the IEEE's *National Electrical Safety Code* book under Rule 92D, which states, "Ground connection points shall be arranged so that under normal circumstances there will be no objectionable flow of current over the grounding conductor" (1996, p. 16).

Also regarding objectionable flow of current, the IEEE's *NESC Handbook, Fourth Edition* (1996) tells us that:

Such flow may be disturbing to the service, as is sometimes the case around dairy barns in which cows are connected to milking systems. ...installations near areas that are often known to present specific problems (such as milking barns without adequate voltage gradient control, pipelines, electric railways, conduits, etc.) may need special attention to limit damage to equipment or uncomfortable conditions for personnel or animals. (p. 30)

In 1991, the United States Department of Agriculture (USDA) published a report entitled "Effects of Electrical Voltage/Current on Farm Animals". Within this report is a section on the electrical power system of the United States, which tells us:

> The U.S. electrical power system is a huge network and is based on a specific transmission, distribution, and utilization philosophy. When consumer equipment consisted primarily of lights, motors, and tube-type electronic equipment, and electrical loads were relatively small, neutral-to earth voltages and transients were not great problems, due to the lower neutral currents and the tolerance of the equipment. With increasing use of low-signal-level solid-state computers and microprocessors, increasing electrification and automation of farms, and increased loads on distribution lines, the issue of power quality and tolerable neutral-to-earth voltage is becoming increasingly important. It will become necessary in the future to more clearly specify the power characteristics that the utility is to provide at the delivery point, the limits to which a consumer's type of usage can he allowed to affect other customers and the utility, and who is to monitor and require conformance to the specifications. The ramifications of meeting these needs are that difficult economic, technical, and legal problems will arise and will have to be solved. (p. 6-2)

A subsequent section on electrical system load growth says:

> The increase in neutral currents and leakage or uncleared fault currents to earth due to electrical load growth...along a distribution line can lead to an increase in the neutral-to-earth voltage. (p. 6-3)

It should be noted that the electric utilities did not create the high frequencies present on their distribution lines due to consumer load growth. The manufacture and use of electronic equipment created the problem, and the electric utilities inherited it. However, the electric utilities are responsible for what is on their lines and for putting the current into the earth, thus allowing currents to flow uncontrolled over the earth's surface. To reiterate – from the first footnote in this report – the term "stray voltage" was coined by electric utilities and public utilities commissions. The word "stray" infers that no one is responsible. There may be stray dogs and stray cats; it may be unknown where they come from or where they are going. Voltage, on the other hand, does not stray; it is governed by scientific laws (Ohm's Law, Kirchhoff's Law, etc.) and it goes where people put it.

Initial Observations and Testing

After arriving in Denmark, WI, I met with Jerome Hlinak and another representative, who escorted me to 6 local residences where they had arranged for me to conduct testing. These local residents believe their families' health problems are directly related to the operation of recently energized wind turbines.

Relying on my extensive experience with diagnosing and troubleshooting electrical problems, and power quality issues in particular, I expected to find distorted 60 cycle sine waves riddled with high frequency transients and harmonics during my testing in the Denmark, WI area. This was, in fact, the case with every measurement I collected, whether from connection points at an area home's kitchen sink to kitchen floor, at utility primary neutral to earth voltage to a remote ground rod, or between two remote ground rods in a resident's yard.

The issue affecting these Denmark, WI area residents is that of high frequency ground currents/voltages, known to many as "stray voltage", or, more properly, electrical pollution (in the case of electrical equipment) and electrical poisoning (in the case of humans and animals). Electrical and electronics engineering societies, utilities, governments, and many other organizations have researched this issue for decades, and trade publications and newspaper articles have addressed this issue for more than the past decade.

Marek Samotyj, EPRI's (Electrical Power Research Institute) manager for power quality stated in a July 5, 1999 *Fortune* magazine article, "Hot New Technologies for American Factories", "[t]he quality situation will get worse before we will be able to mitigate it . . . One reason is that EPRI [Electrical Power Research Institute] expects 70% of all electricity produced within the U.S. to flow through electronic devices by 2002, vs. 30% today" (Bylinski, p. 4)

An article by Beck Ireland in the September 2006 edition of EC&M, "Clearing up Confusion on Unwanted Voltages", highlights numerous incidents of "stray voltages" affecting humans, animals, and electric utilities, including:

- East Village, NY, 2004: Jodie S. Lane, a 30-year-old Columbia University graduate student, was killed when she stepped on a metal plate.
- Feb 12, 2006: Four people shocked by service box near Port Authority Bus Terminal.
- Feb 17, 2006: Dog electrocuted on patch of concrete in Park Slope Brooklyn
- March 2006: Nine-year old boy hospitalized after an electric jolt while walking over a metal plate in Harlem.
- March 2006: New York City's Consolidated Edison found 1,214 instances of stray voltage during a year-long examination of electrical equipment on city streets.
- Con Ed expects to spend $100 million this year [2006] toward reducing the risk of stray voltage.

More recent evidence of this issue can be found in a *Toronto Sun* newspaper article, "Children Shocked by Stray Voltage", where Don Peat reports, "Several children shocked by stray voltage – just two weeks after a second dog was electrocuted – has finally prompted Toronto Hydro to mobilize 600 workers to inspect its aging street-level infrastructure" (January 30, 2009).

The issue of ground current has been addressed not only in consumer publications, but also in electrical industry engineering manuals, code books and other published guidelines. For example, the *Wiley Encyclopedia of Electrical and Electronics Engineering, Volume 8* (1999), states, "It is an unsafe practice to allow current to flow over the earth continuously, uncontrolled. All continuously flowing current must be contained within insulated electrical conductors". Also, in a 2006 white paper "BC Hydro Deals With Farm Neutral to Earth Voltage", David M. Rogers, an Agricultural Specialist for BC Hydro, states:

> The Canadian Electrical Code Rule 10-200 states that concerning "The Rule (for grounding and bonding conductors) does not intend there be current flowing through the bonding and grounding system during normal operation." Its Subrule (3) of Chapter 10-200 states that: "Where by using multiple grounds objectionable flow of current occurs over the grounding conductor:
>
> - One or more of the grounds shall be abandoned;
> - The location of the grounds shall be changed;
> - The continuity of the conductor between the grounding connections shall be suitably interrupted;
> - Other effective action shall be taken to limit the current." (p.3)

According to Rogers (2006), BC Hydro has developed a positive approach to dealing with the issue of ground currents/voltages, ultimately producing positive results for both Canadian farmers and BC Hydro, including, 1) a reduction in mastitis in farms at any one time from 230 in 1997 to fewer than 20 in the period from 2003 to 2006, and, 2) never having had a legal suit over farm ground current/voltage issues (p. 13).

With regard to wind turbines contributing to ground currents/voltages, I will offer this information. IEEE Std. 519-1992 states:

> The emergence of renewable, alternate energy sources has resulted in the use of many varied topologies as power conditioners or inverters for utility tied operation. These inverters are available in single-phase units and in three-phase units, and their outputs may be very clean sinusoids with near unity power factor or may contain various characteristic and noncharacteristic harmonics and power factors that may cause unacceptable power quality on the electric utility grid or interfere with its controls or relays. (p. 23)

To summarize, this issue has been well-publicized and well-documented.

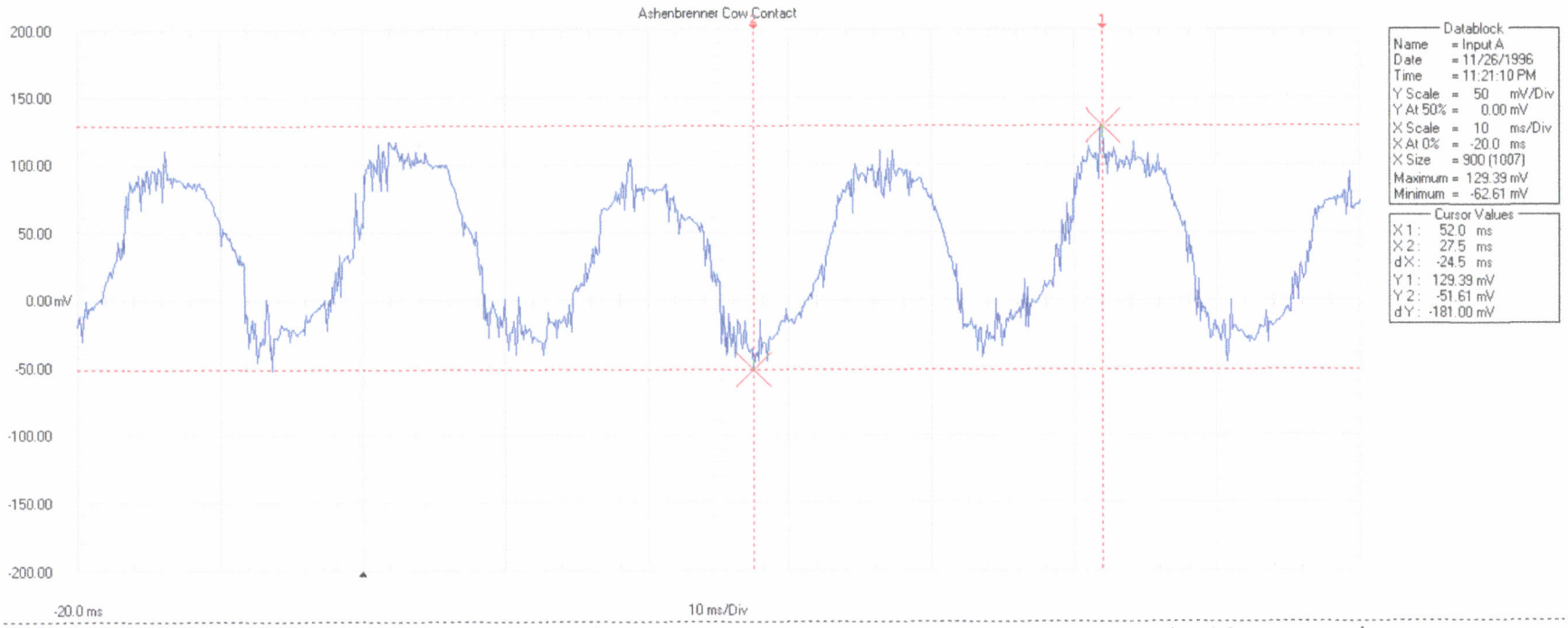
After my initial meeting with Jerome, we proceeded to several (6) Denmark, WI area homes to conduct testing. At each home I used a Fluke 199 two-channel Scopemeter to collect readings from 1) kitchen sink to kitchen floor and 2) utility primary neutral to earth voltage (PNEV) from the nearest utility down ground. When PNEV was unavailable for measurement, readings were collected from 2 remote ground rods placed in the resident's yard. The measurement results are presented below following a brief commentary.

My research into the issue of ground currents/voltages, spanning more than the past decade, has allowed me to gather a vast library of information in the form of books, industry publications and codes,

peer-reviewed journal articles, scientific experiments, etc. I will provide here a few pertinent statements to keep in mind while reviewing the following data.

1) Frequencies above 1.7 kHz dissipate internally to the human body (Reilly, 1992).
    - Frequency spectrums of the collected waveforms show that residents in these locations are exposed to frequencies well in excess of 1.7 kHz.
2) "...the absolute (as well as the modest) level of contact current modeled (18 uA) produces average electric fields in tissues along its path that exceed 1mV/m. At and above this level, the NIEHS Working Group [1998] accepts that biological effects relevant to cancer have been reported in numerous well-programmed studies" (Kavet, 2000).
    - Analysis of collected waveforms indicates that residents in test locations are exposed to anywhere from 16 to 291 times this amount of current.
3) Symptoms of Microwave and Radio-Frequency Radiation (excerpted from NMRI, 1972)
    - Headaches
    - Heart Palpitations/Arrhythmia
    - Fatigue
    - Muscle spasms
    - Weakness
    - Insomnia
    - Digestive problems
    - Anxiety
    - Depression
    - Altered sugar metabolisms (Diabetes)
    - Sinusitis
    - Nausea
    - Deteriorating Vision
    - Difficulty concentrating
    - Memory Loss
    - Muscle & joint pain
    - Breathing Difficulties

Ashenbrenner

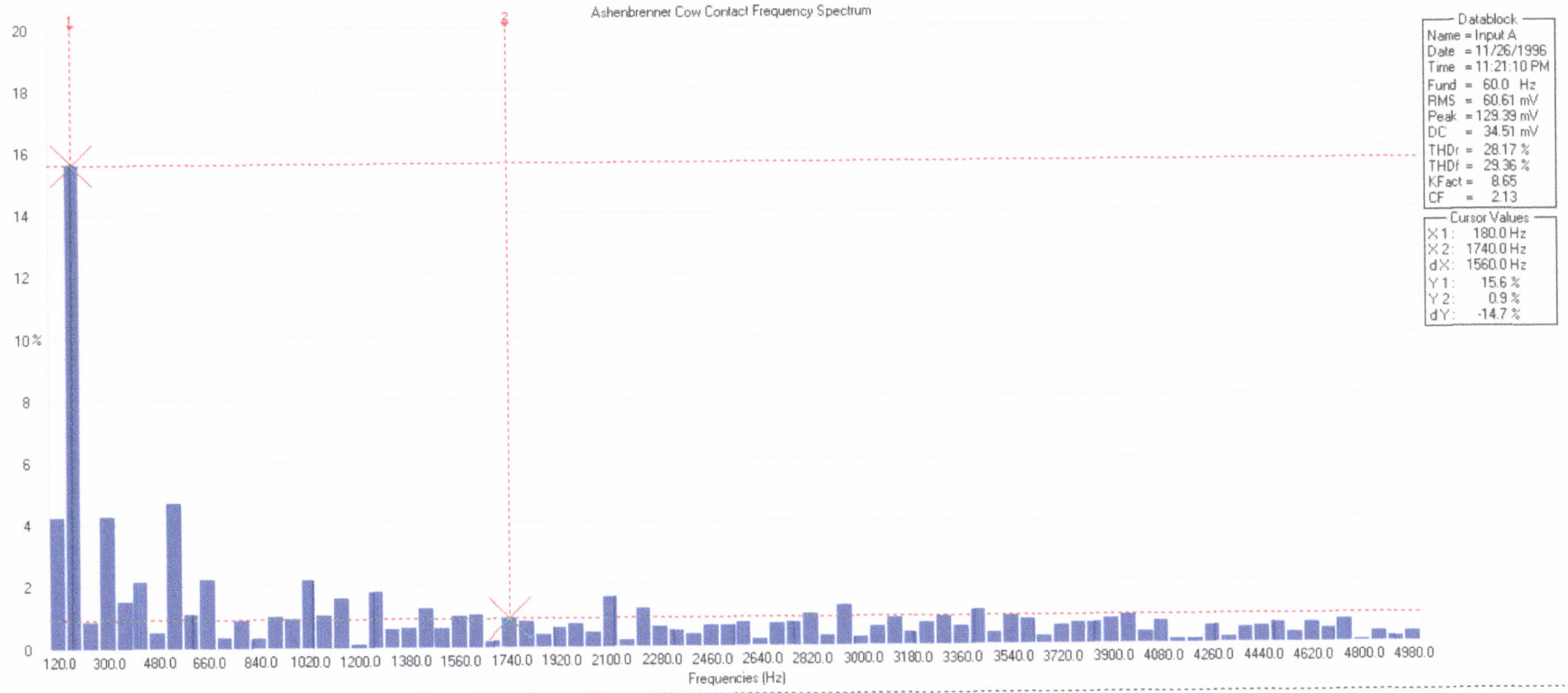


The waveform was collected with a Fluke 199 Scopemeter at the Kevin Ashenbrenner farm. Leads were connected between a 19 square inch stainless steel plate and the water pipe (cow contact). The voltage displayed on the above waveform is 181 mV.

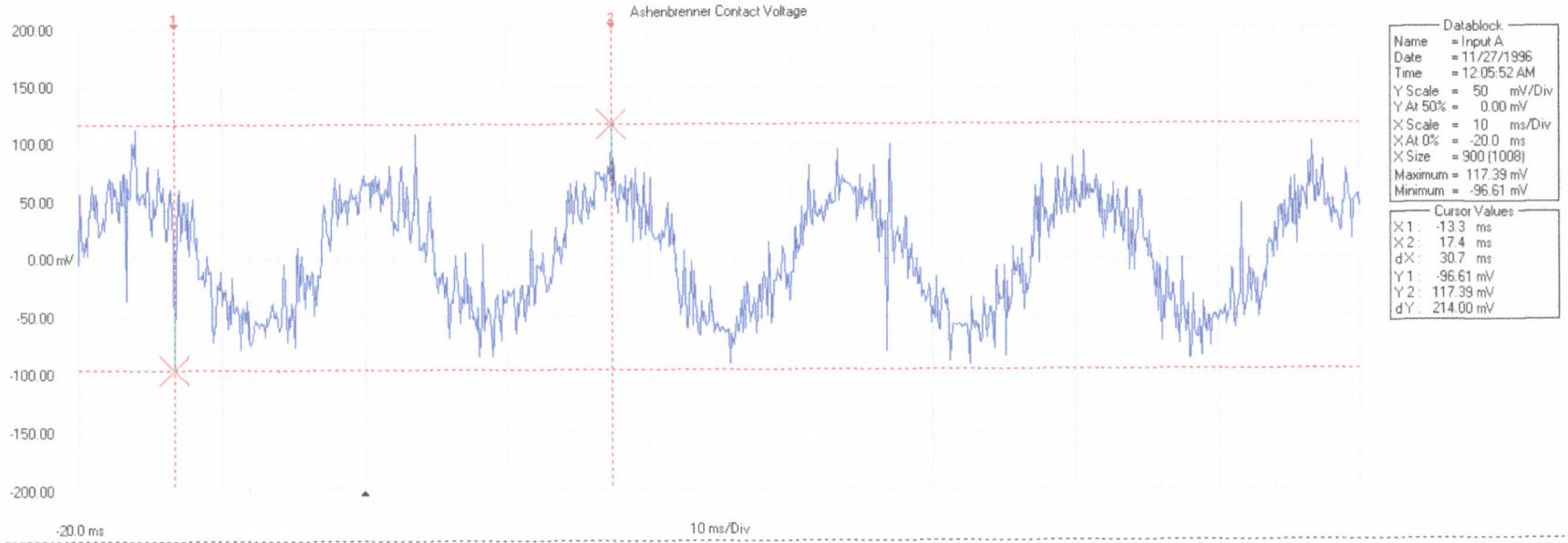
"... a potential difference between front and hind hooves of a dairy cow, much less than the often quoted threshold value of 0.5 V, when applied for long periods of time, could possibly affect cow health and milk production. Values as low as approximately 10 mV could conceivably be significant" (Polk, 2001).

"...we estimated that a front-to-rear hoof step potential exposure of 0.002 to 0.02 volts would produce such field strengths in the cow's leg muscle tissue" (Final Report of the Science Advisors to the Minnesota Public Utilities Commission, 1998).

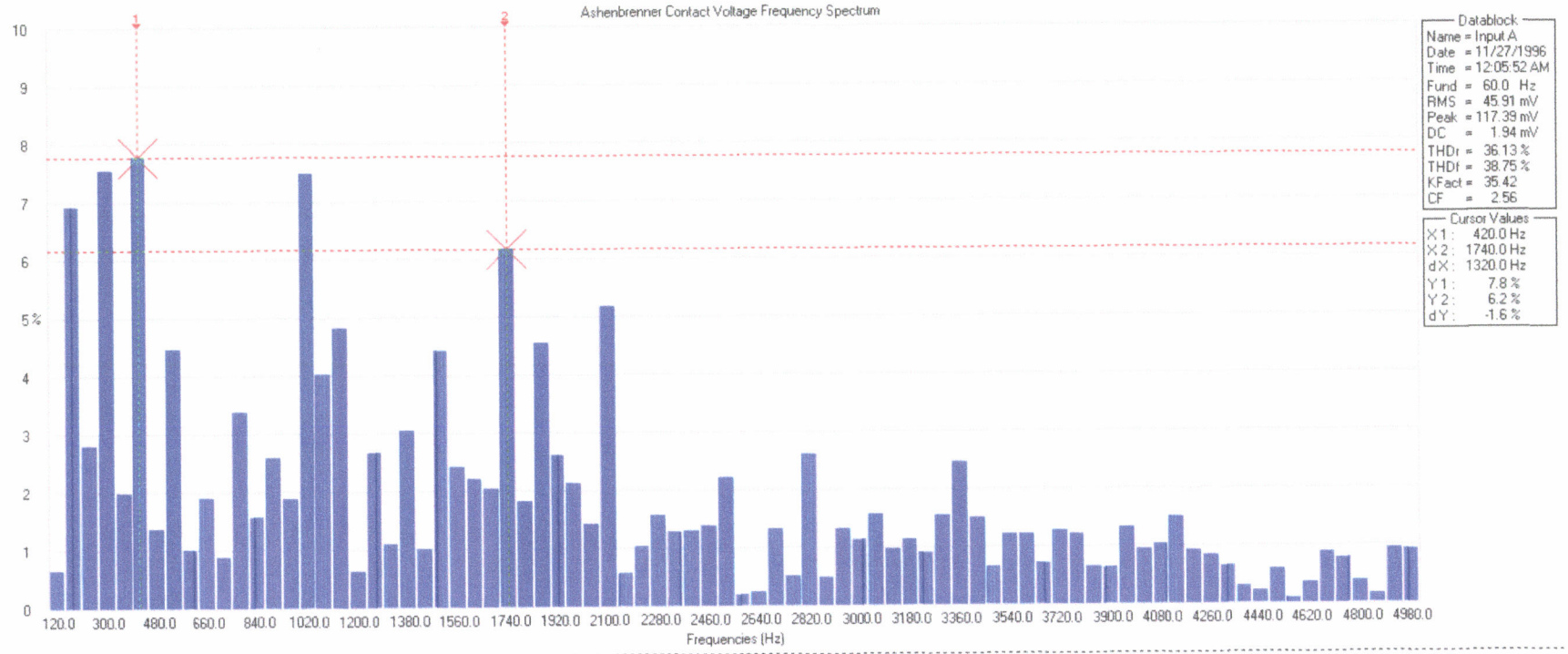
"Exposure to E&MF (on) resulted in an average decrease of 4.97, 13.78, and 16.39% in milk yield, fat corrected milk yield, and milk fat, respectively; and an increase of 4.75% in dry matter intake" (Burchard, Monardes, & Nguyen, 2003).



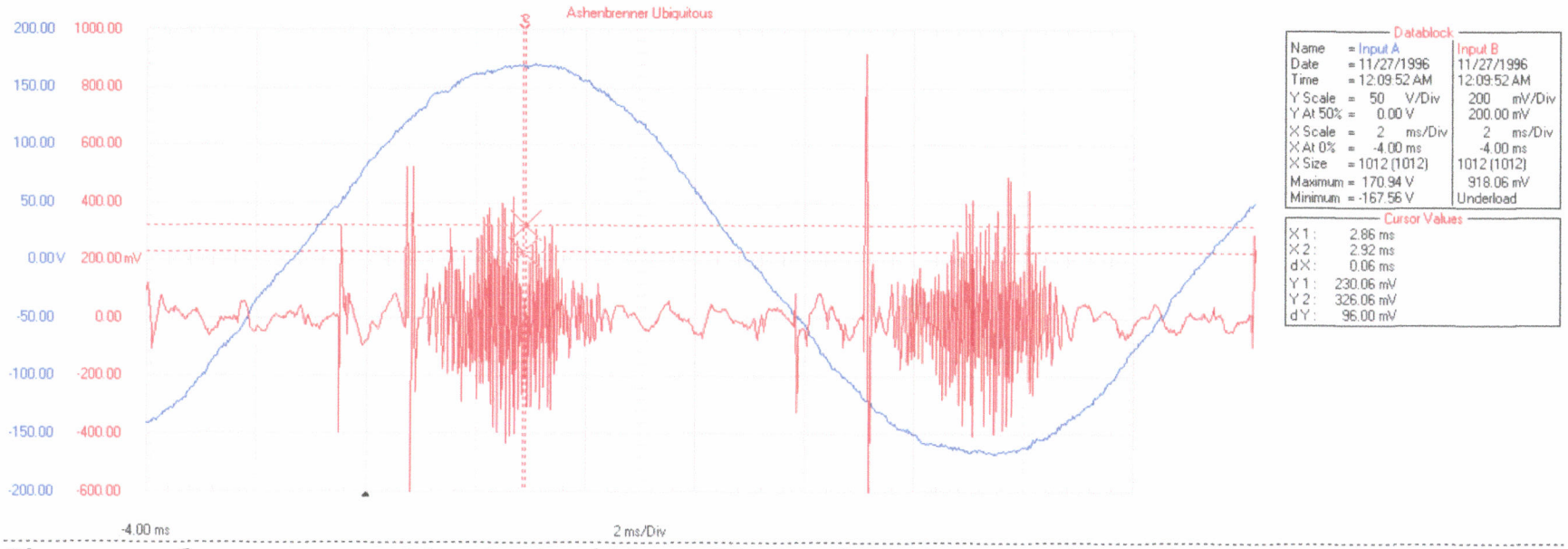
The frequency specrtum is of the cow a cow contact voltage waveform collected in the barn of Kevin Ashenbrenner, near Denmark WI.



The waveform was collected with a Fluke 199 Scopemeter at the Kevin Ashenbrenner home. The leads were connected betweeen the kitchen sink and an EKG patch placed on the floor. (Contact Voltage) Assuming a person has an impedance of 500 Ohms, the contact current would be 428 micro amperes or more than 23 times the current the NIEHS states is relevant to cancer.

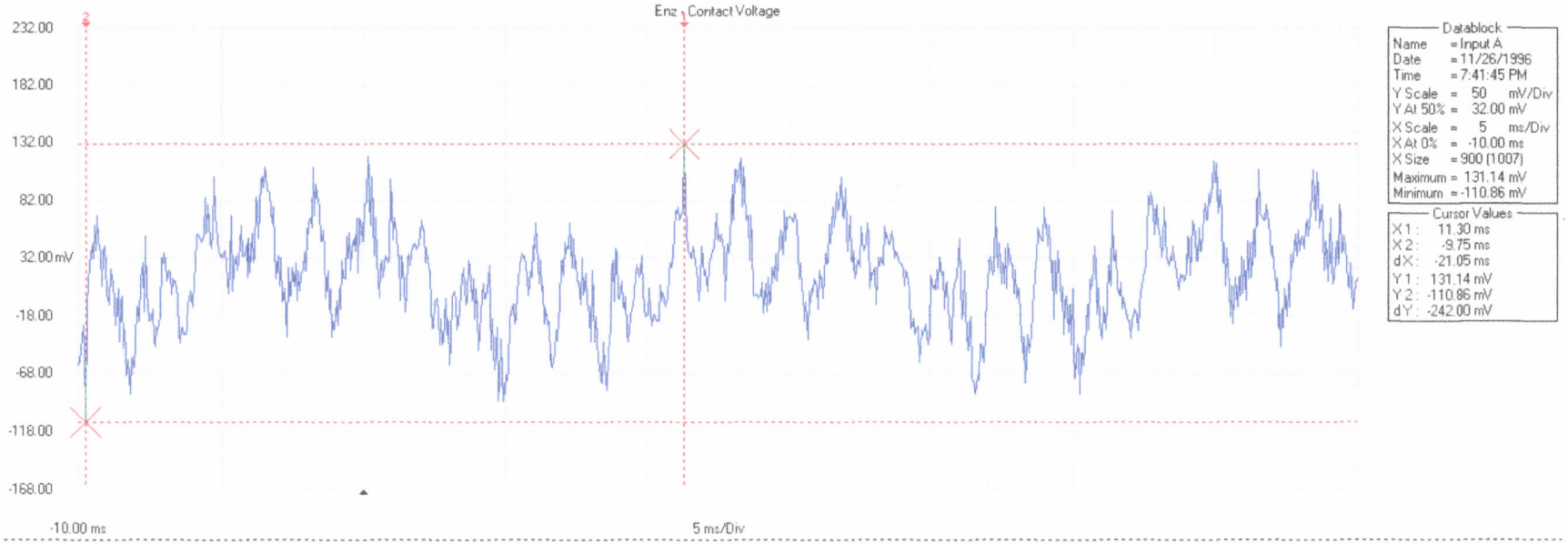


The above frequency spectrum is of a waveform collected between the sink and floor (contact Voltage) at the Kevin Ashenbrenner home near Denmark, WI.

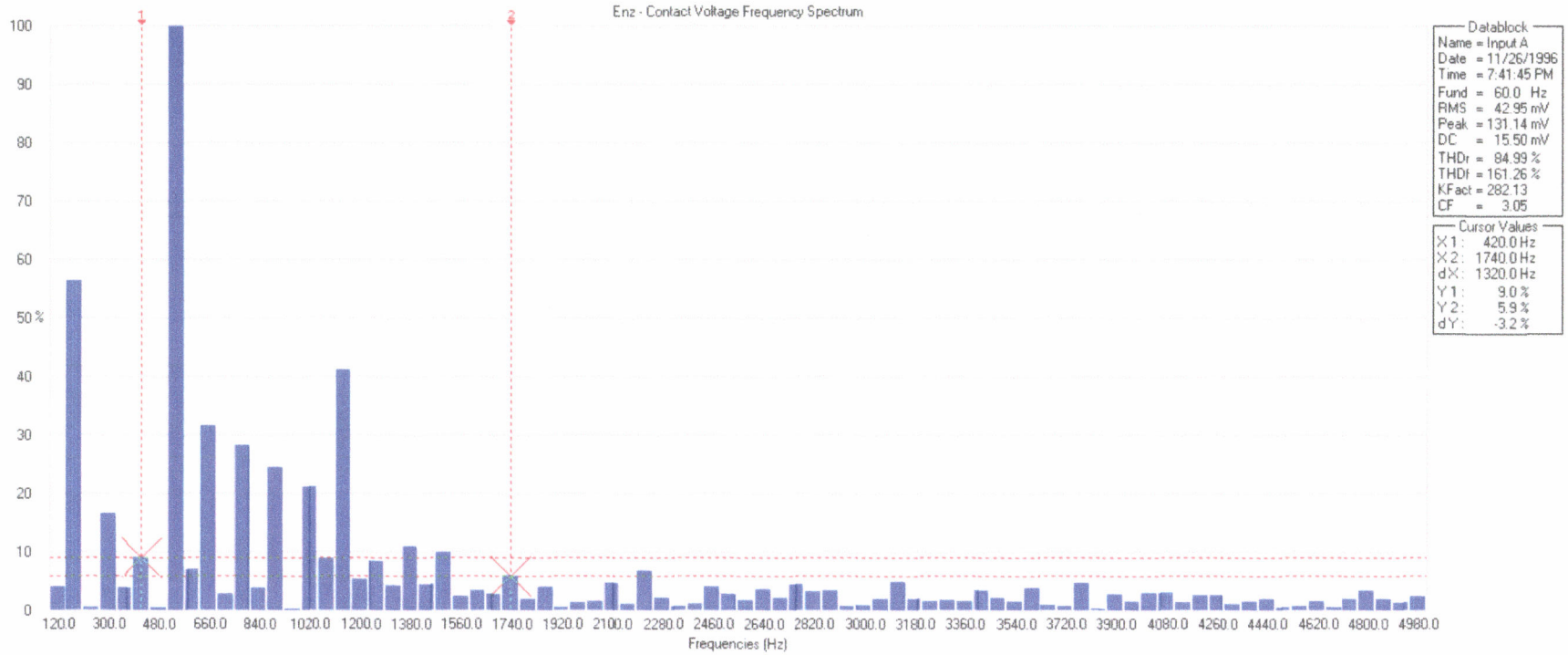


The waveform was collected with a Fluke 199 Scopemeter at the Kevin Ashenbrenner home. Channel A was connected to a 120V receptacle. Channel B was connected at the same potential except through the Graham ubiquitous filter (removes the 60 cycle). The area between the cursors represents a frequency of 16.6 kHz. The high frequency is riding on the utility supplied 60 cycle waveform.

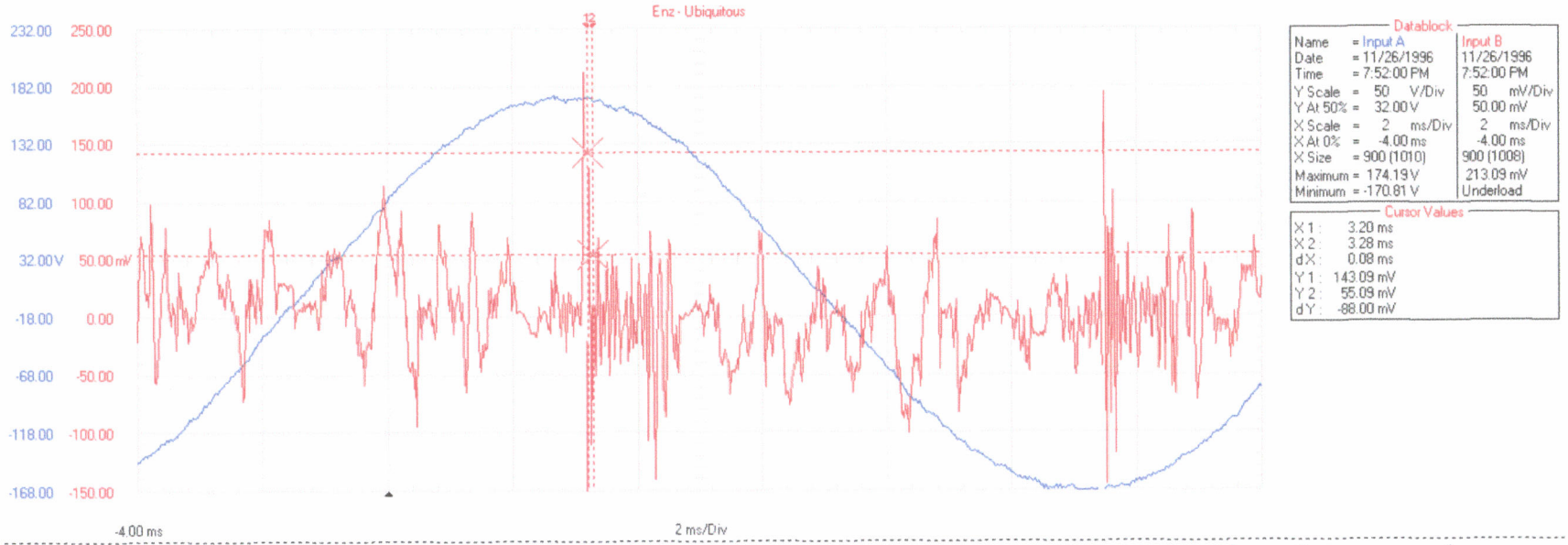
Enz



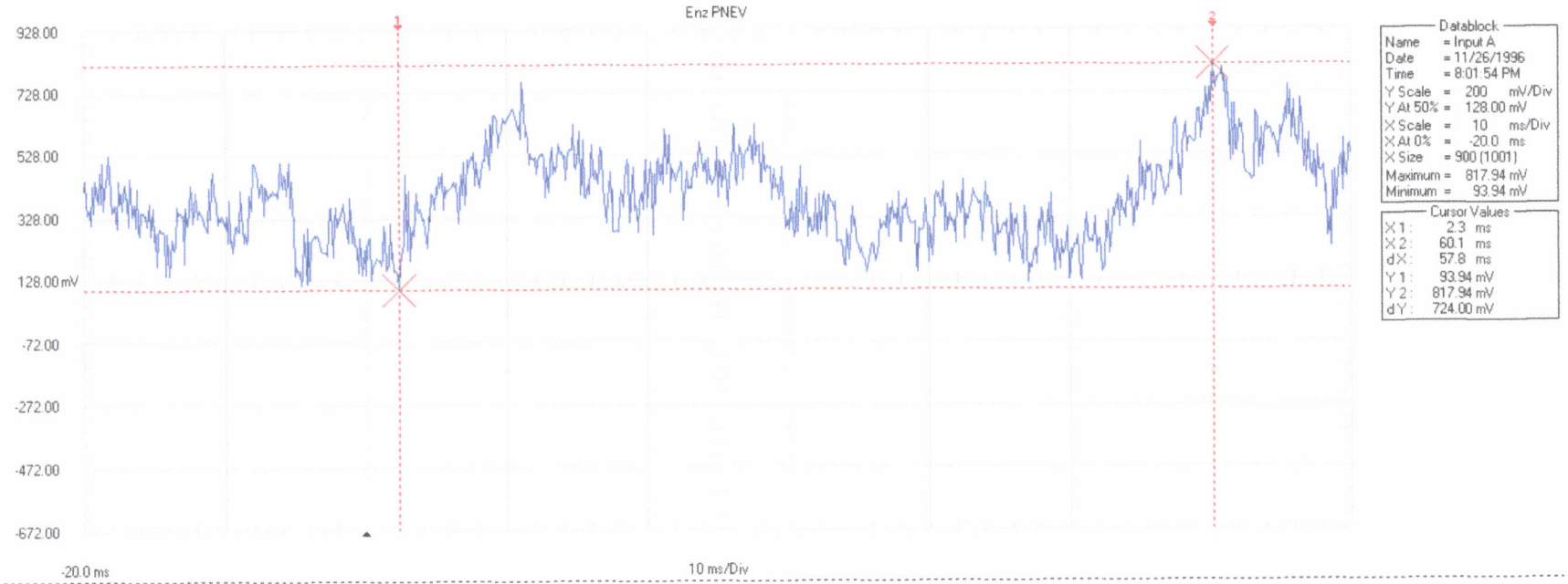
The waveform was collected with a Fluke 199 Scopemeter at the Dave and Rosemary Enz home. The leads were connected betweeen the kitchen sink and an EKG patch placed on the floor. (Contact Voltage) Assuming a person has an impedance of 500 Ohms, the contact current would be 484 micro amperes or more than 26 times the current the NIEHS states is relevant to cancer.



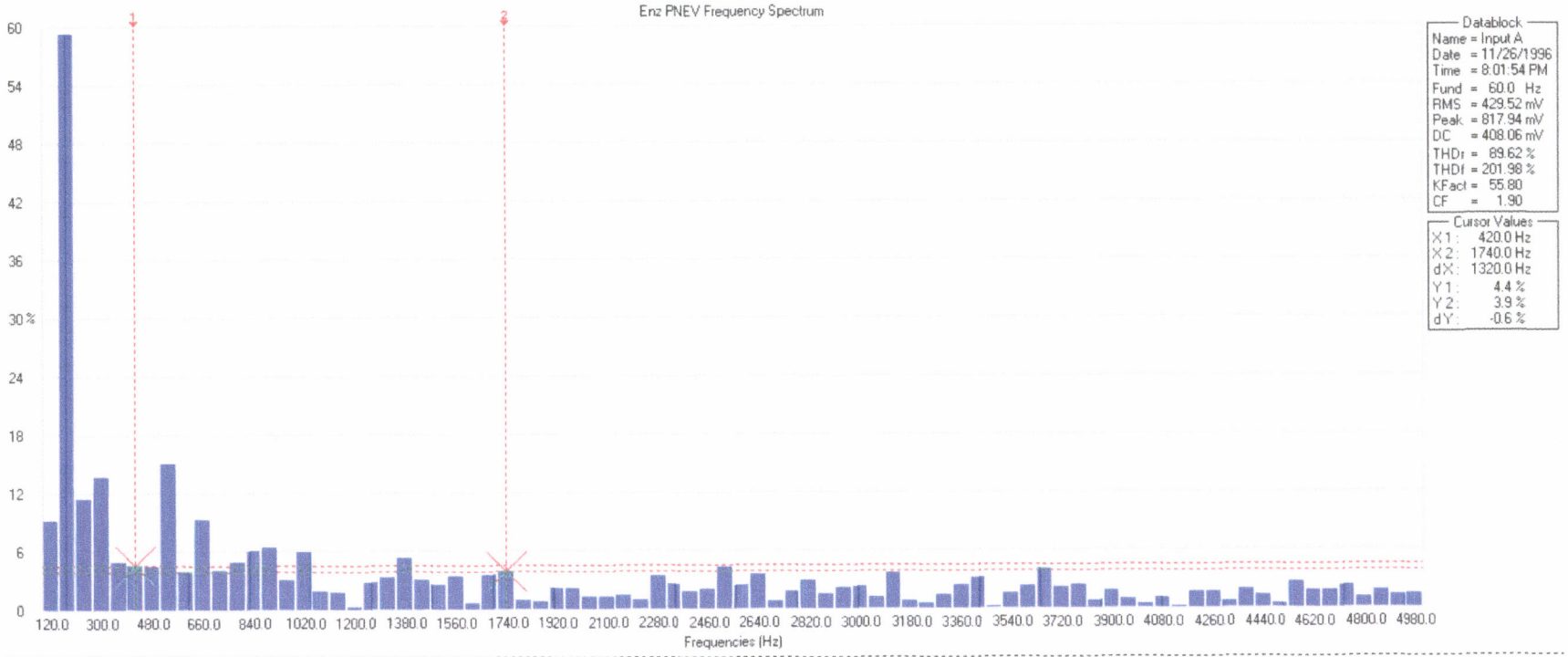
The above frequency spectrum is of a waveform collected between the sink and floor (contact Voltage) at the Dave and Rosemary Enz home near Denmark, WI.



The waveform was collected with a Fluke 199 Scopemeter at the Dave and Rosemary Enz home. Channel A was connected to a 120V receptacle. Channel B was connected at the same potential except through the Graham ubiquitous filter (removes the 60 cycle). The area between the cursors represents a frequency of 12.5 kHz. The high frequency is riding on the utility supplied 60 cycle waveform.

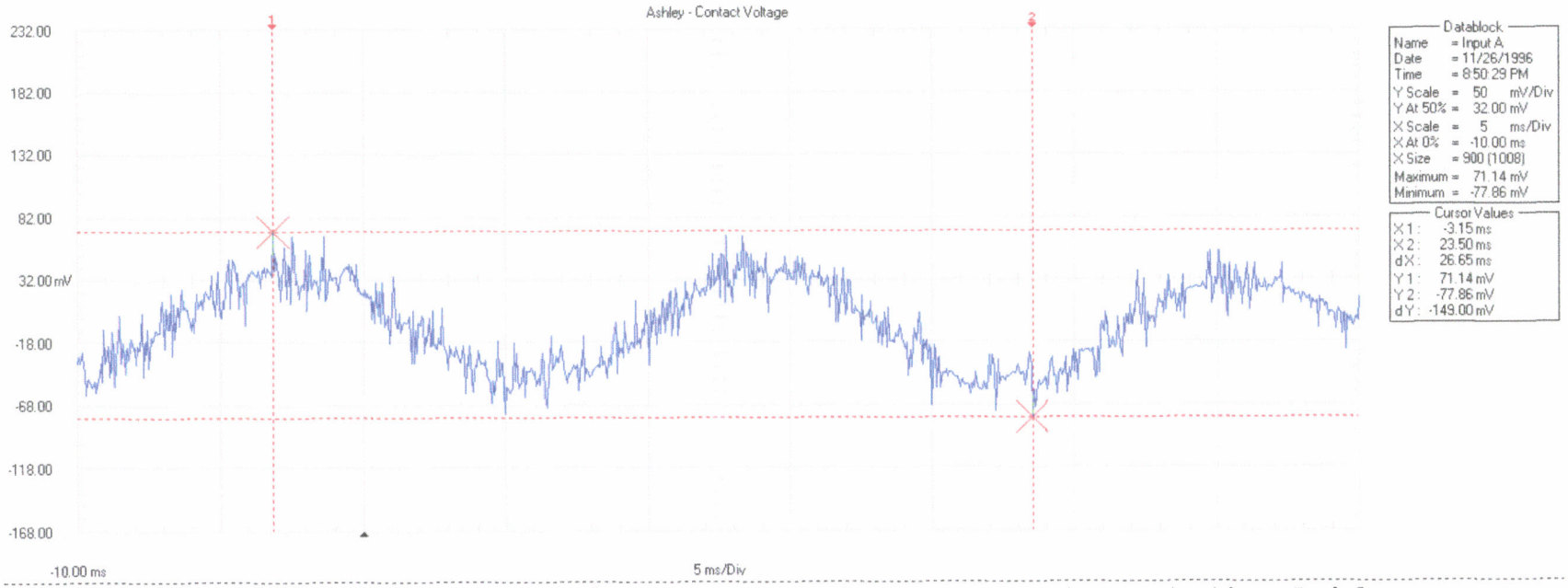


The distorted waveform was measured with a Fluke 199 Scopemeter at PNEV at the transformer down ground across the road from the Enz home near Denmark, WI. One lead was connected to the utlityprimary down ground and the other to a remote ground rod. The windturbines were running in close proximity to the measurement points.

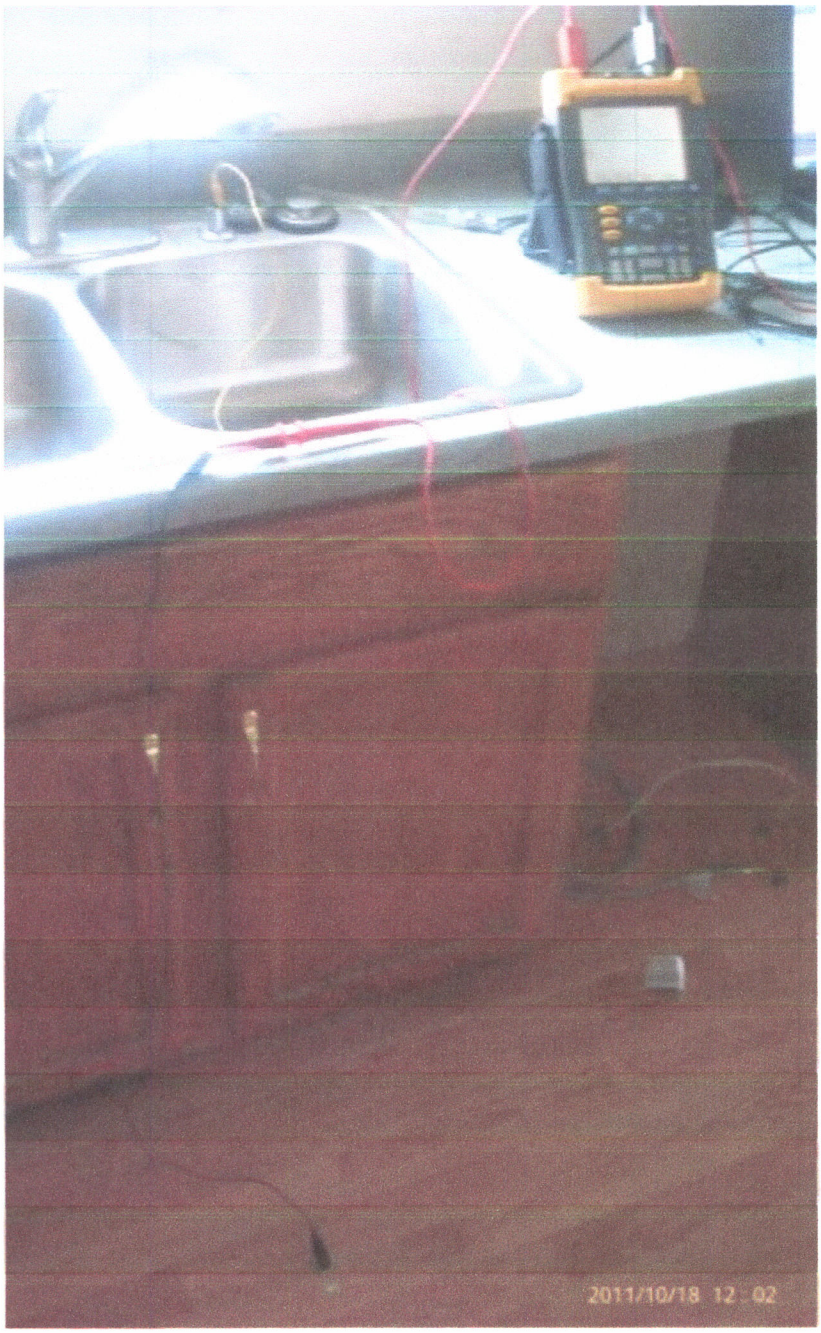


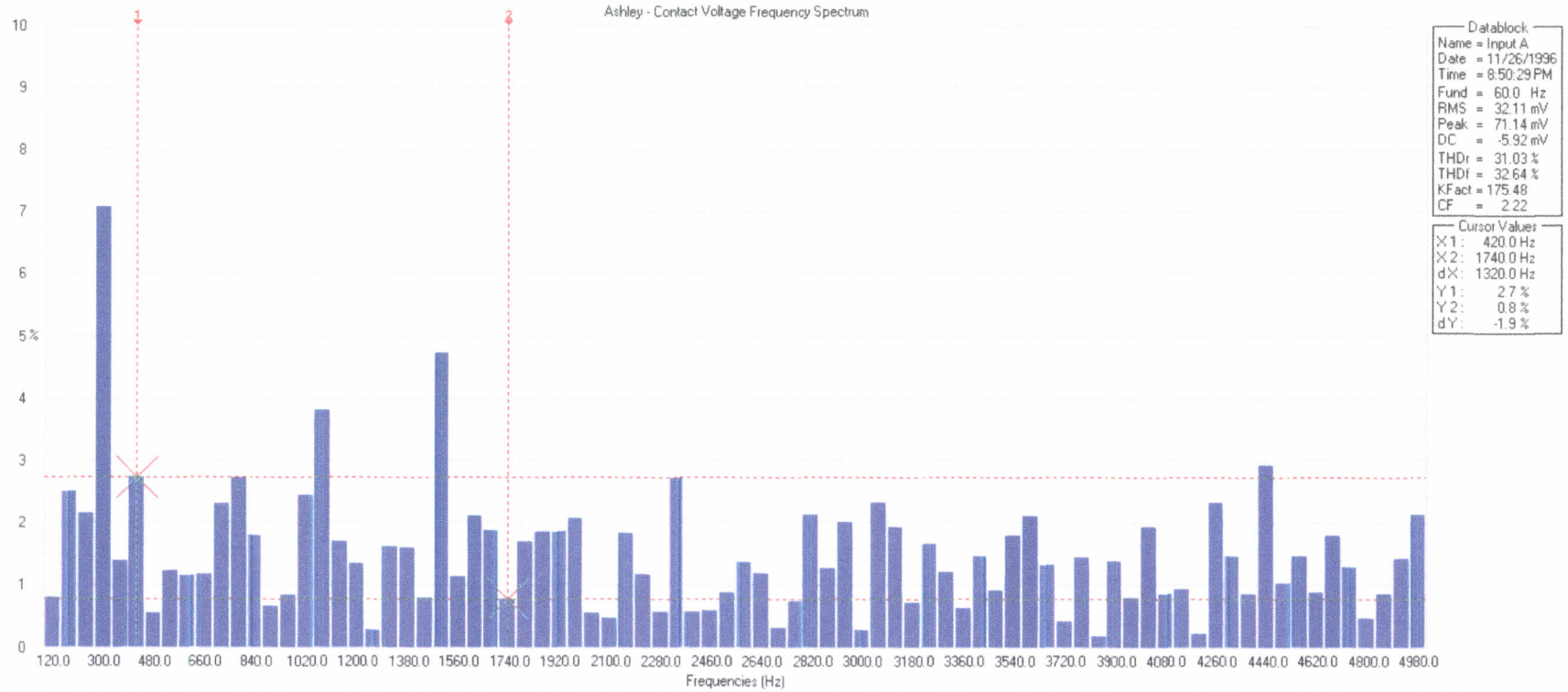
The above frequency spectrum is of a waveform collected at primary neutral to earth voltage at the transformer down ground across the road from the Dave and Rosemary Enz home near Denmark, WI.

Ashley

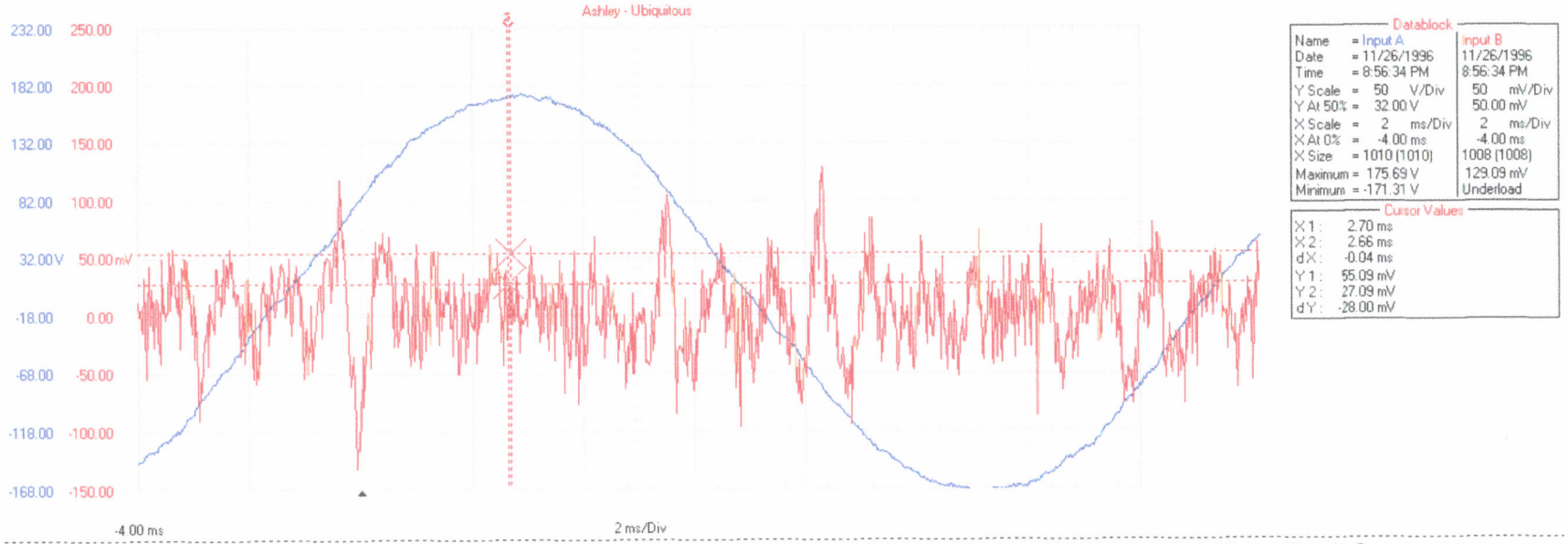


The waveform was collected with a Fluke 199 Scopemeter at the Ashley home. The leads were connected betweeen the kitchen sink and an EKG patch placed on the floor. (Contact Voltage) Assuming a person has an impedance of 500 Ohms, the contact current would be 298 micro amperes or more than 16 times the current the NIEHS states is relevant to cancer.


2011/10/18 12:02

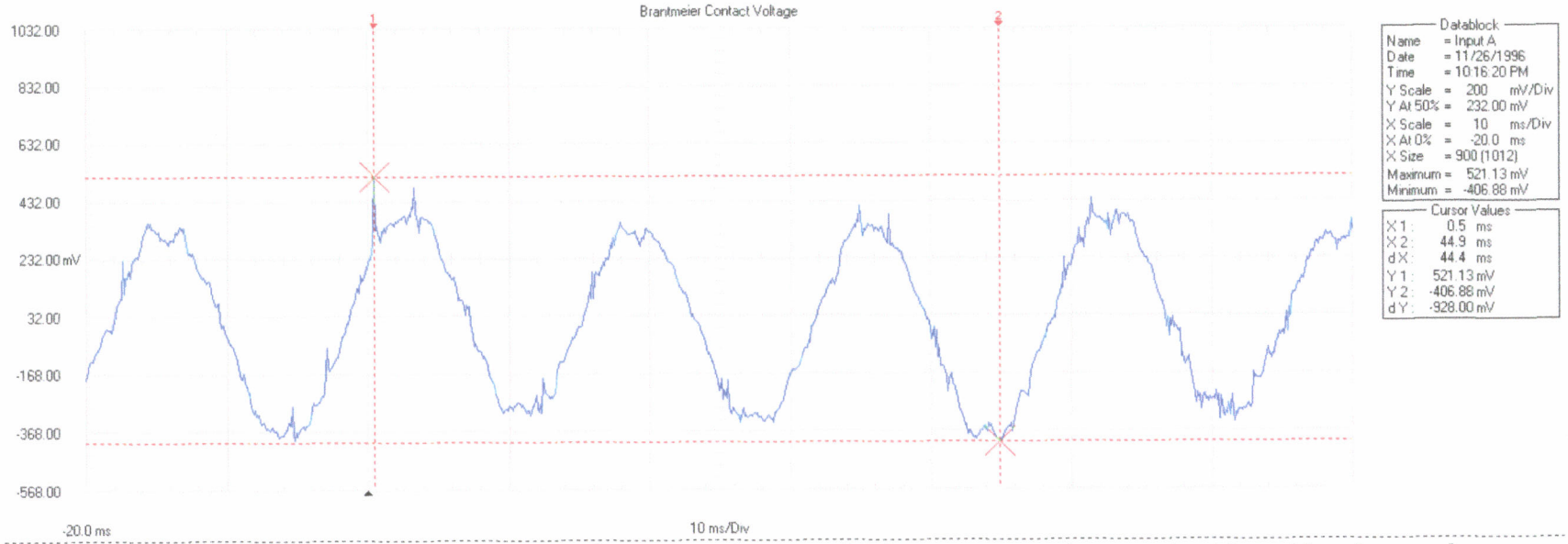


The above frequency spectrum is of a waveform collected between the sink and floor (contact Voltage) at the Ashley home near Denmark, WI.

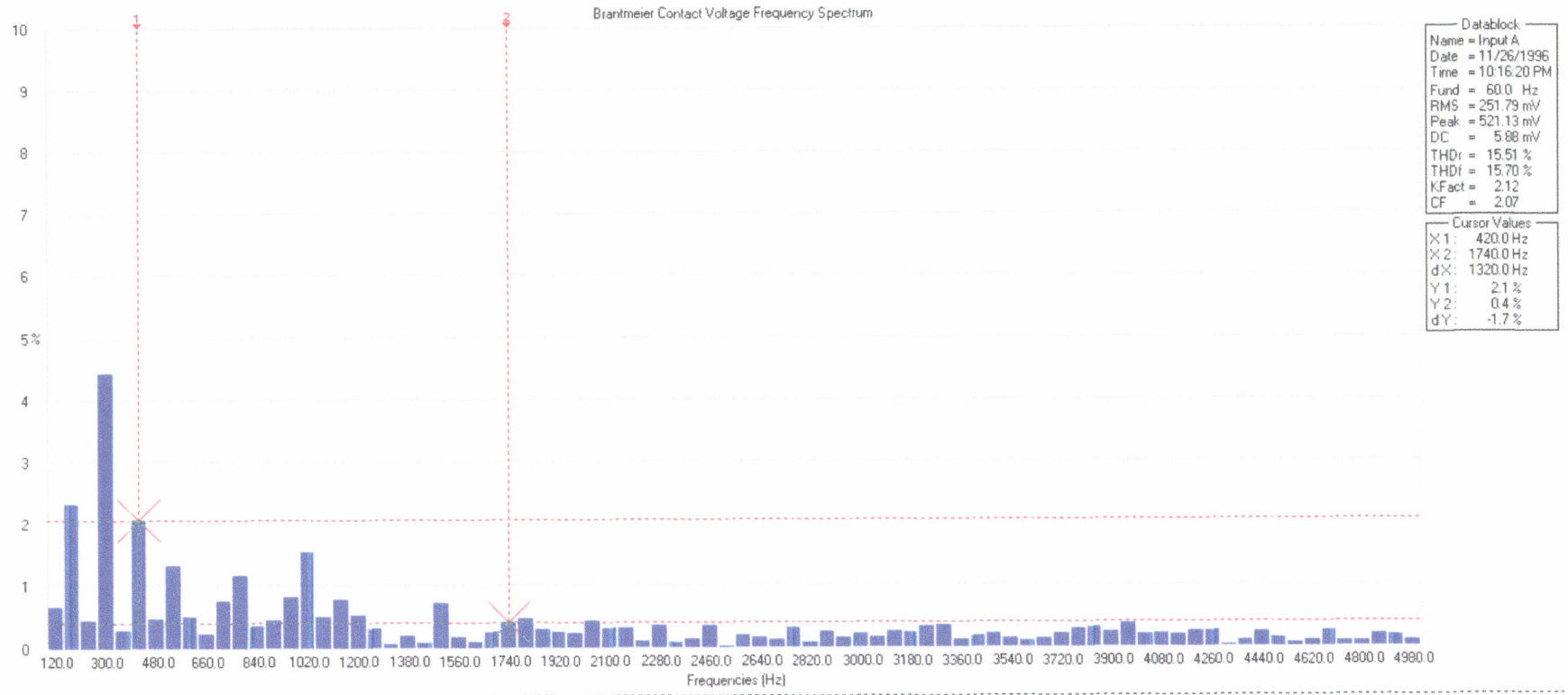


The waveform was collected with a Fluke 199 Scopemeter at the Ashley home. Channel A was connected to a 120V receptacle. Channel B was connected to the same potential except through a Graham ubiquitous filter (removes the 60 cycle). The area between the cursors represents a frequency of 25 kHz. The high frequency is riding on the utility supplied 60 cycle waveform.

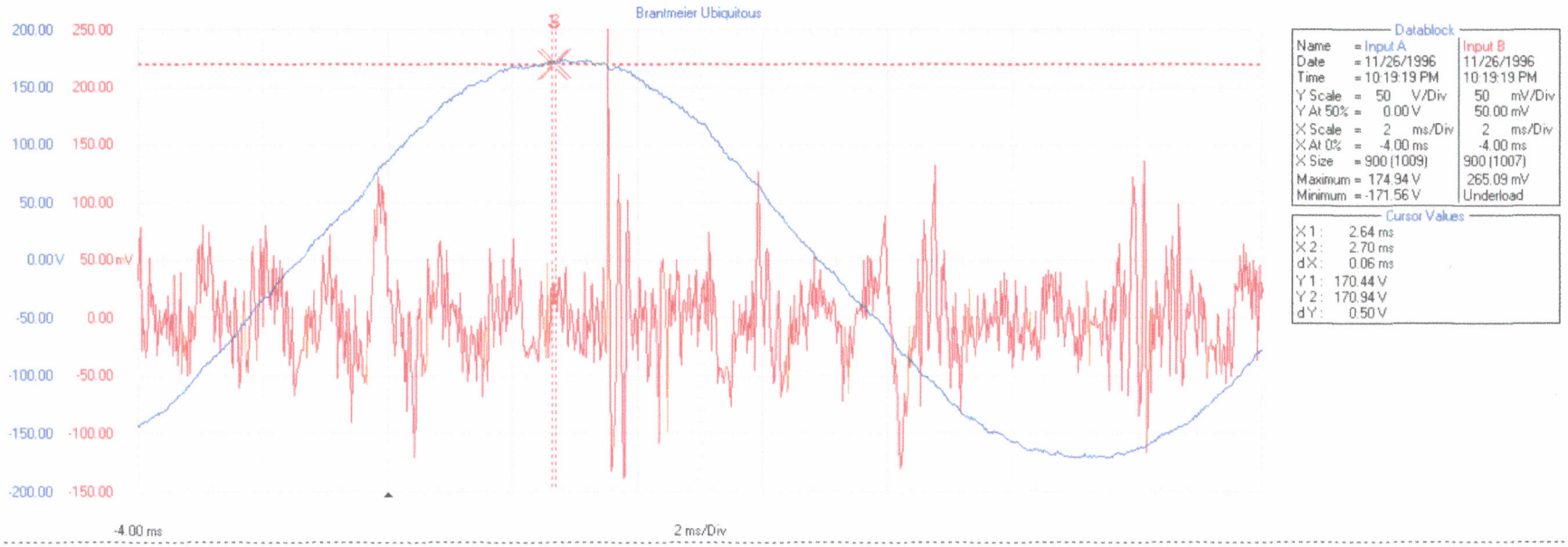
Brantmeier



The waveform was collected with a Fluke 199 Scopemeter at the Mark and Tammy Brantmeier home. The leads were connected betweeen the kitchen sink and an EKG patch placed on the floor. (Contact Voltage) Assuming a person has an impedance of 500 Ohms, the contact current would be 1856 micro amperes or more than 103 times the current the NIEHS states is relevant to cancer.

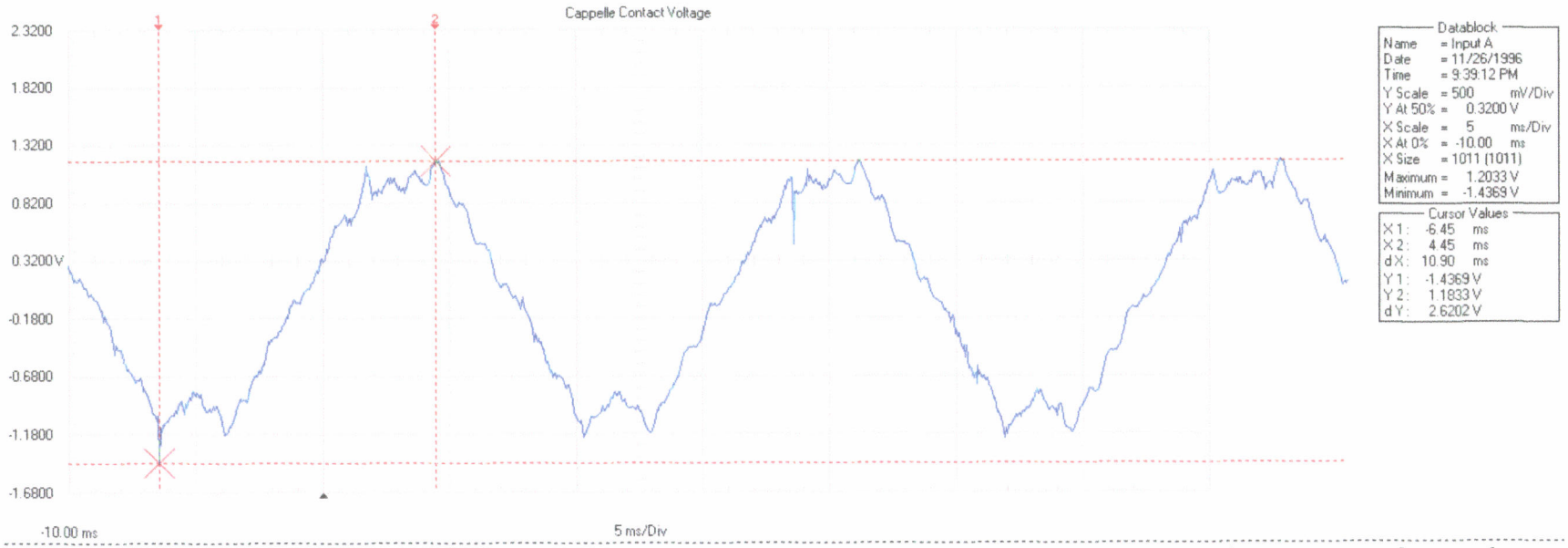


The above frequency spectrum is of a waveform collected between the sink and floor (contact Voltage) at the Brantmeier home near Denmark, WI.



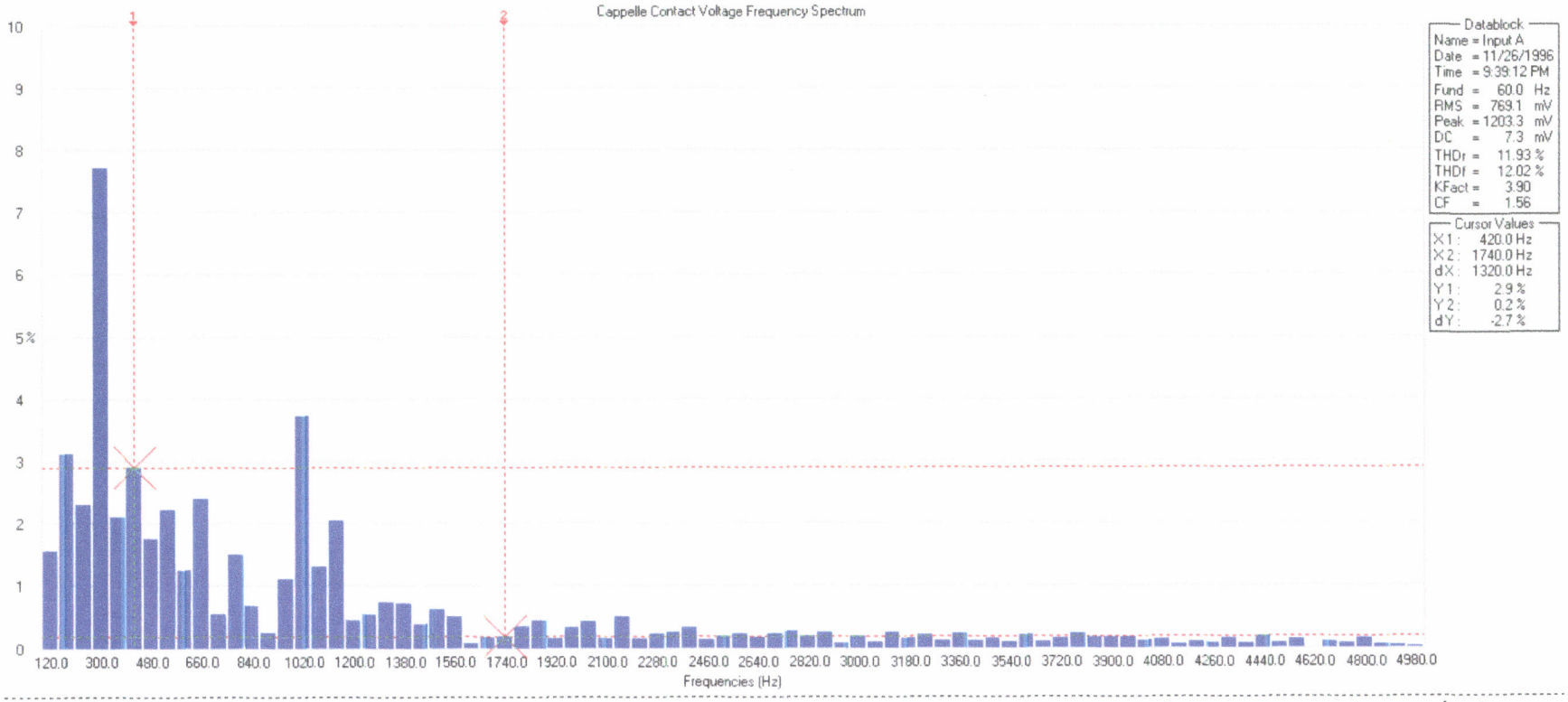
The waveform was collected with a Fluke 199 Scopemeter at the Mark and Tammy Brantmeier home. Channel A was connected to a 120V receptacle. Channel B was connected at the same potential except through the Graham ubiquitous filter (removes the 60 cycle). The area between the cursors represents a frequency of 16.6 kHz. The high frequency is riding on the utility supplied 60 cycle waveform.

Cappelle

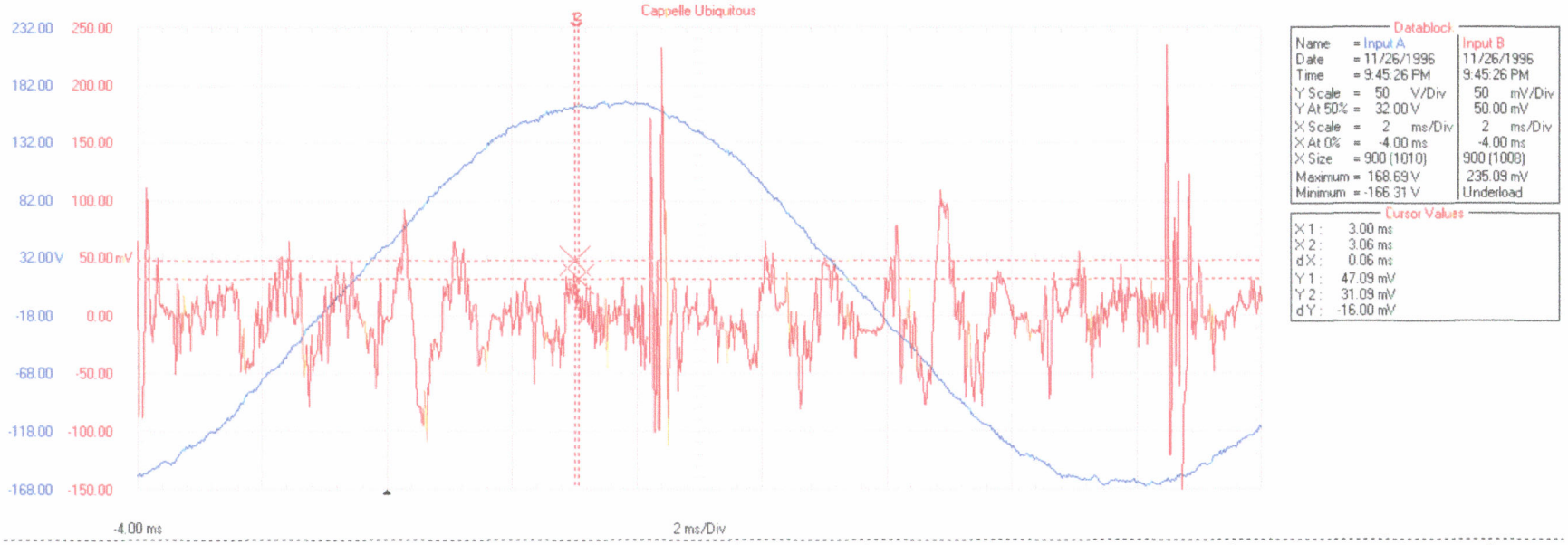


The waveform was collected with a Fluke 199 Scopemeter at the Darrel and Sarah Cappelle home. The leads were connected betweeen the kitchen sink and an EKG patch placed on the floor. (Contact Voltage) Assuming a person has an impedance of 500 Ohms, the contact current would be 5,240 micro amperes or more than 291 times the current the NIEHS states is relevant to cancer.

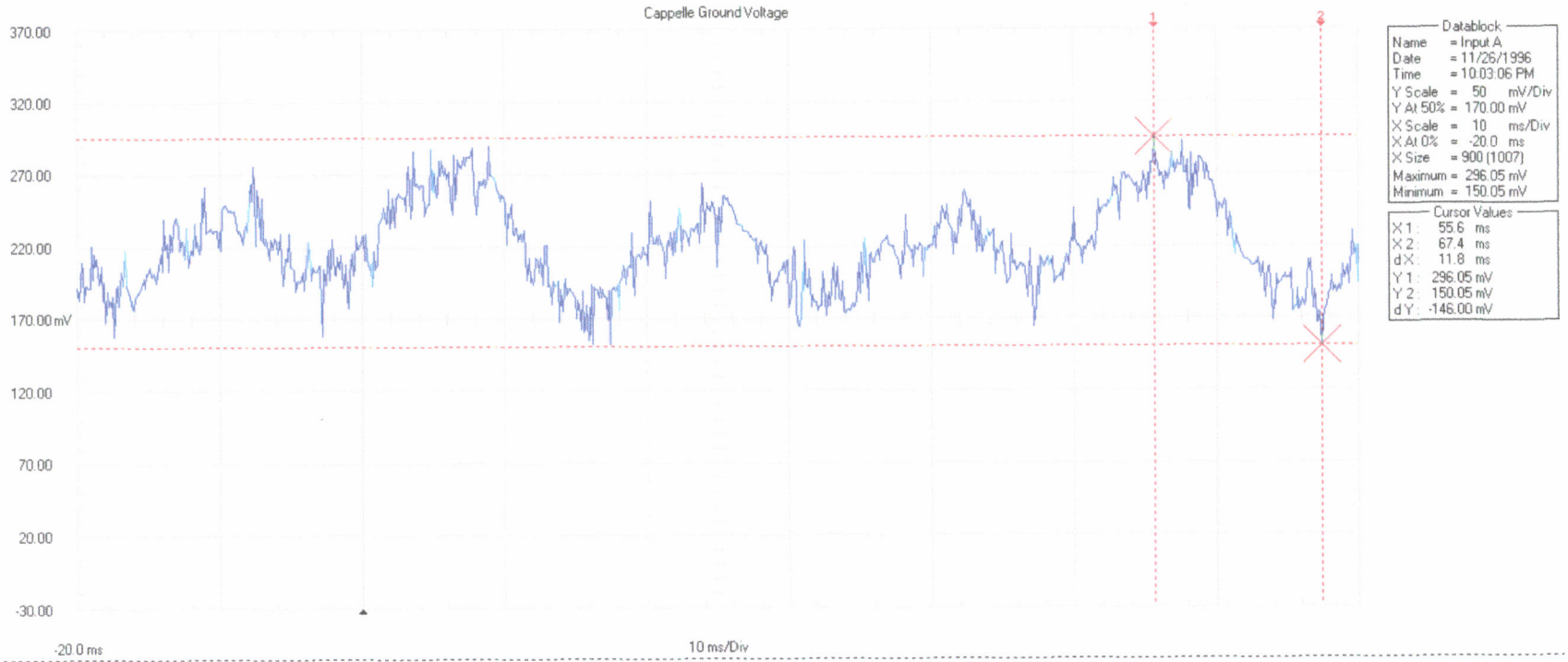

2011/10/18 12:48



The above frequency spectrum is of a waveform collected between the sink and floor (contact Voltage) at the Cappelle home near Denmark, WI.



The waveform was collected with a Fluke 199 Scopemeter at the Darrel and Sarah Cappelle home. Channel A was connected to a 120V receptacle. ChannelB was connected at the same potential except through the Graham ubiquitous filter (removes the 60 cycle). The area between the cursors represents a frequency of 16.60kHz. The high frequency is riding on the utility supplied 60 cycle waveform.



The distorted waveform was measured with a Fluke 199 Scopemeter. The leads were connected between two remote ground rods in the yard of Darrel and Sarah Cappelle.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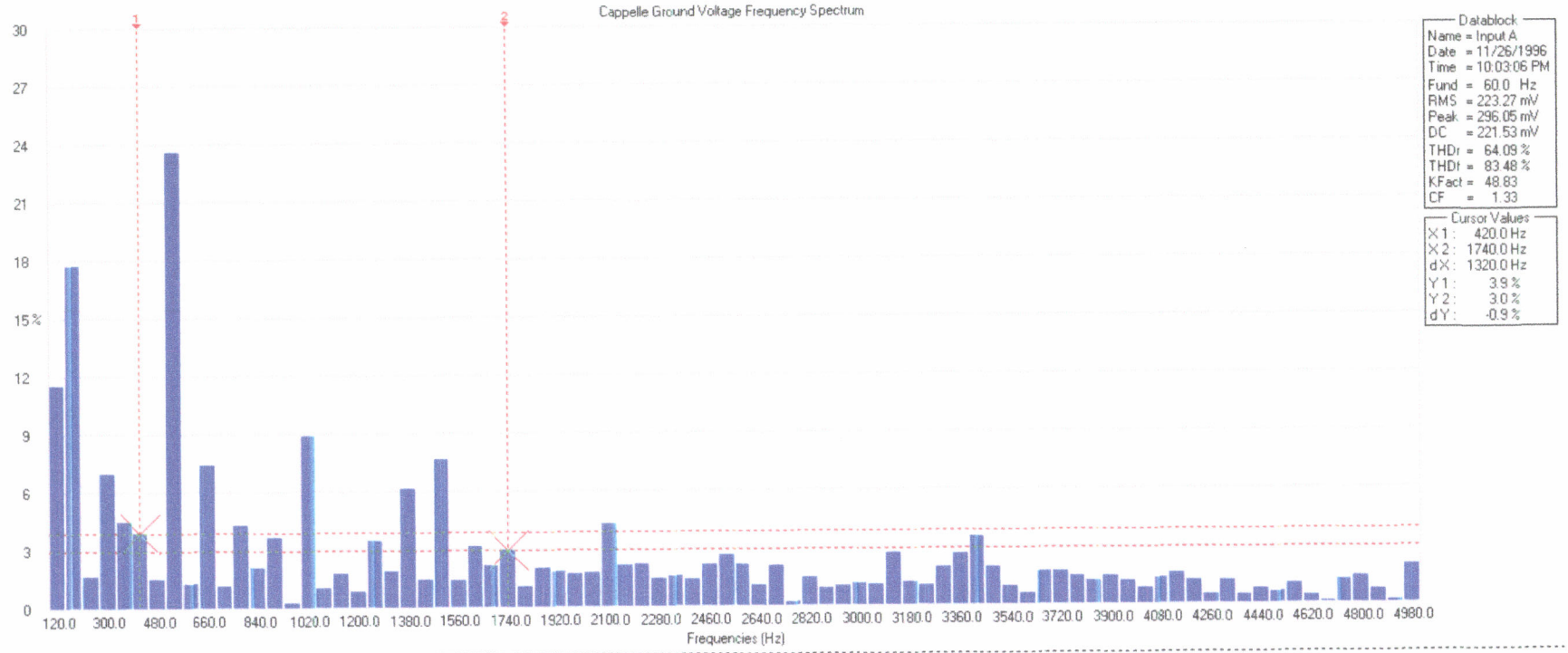
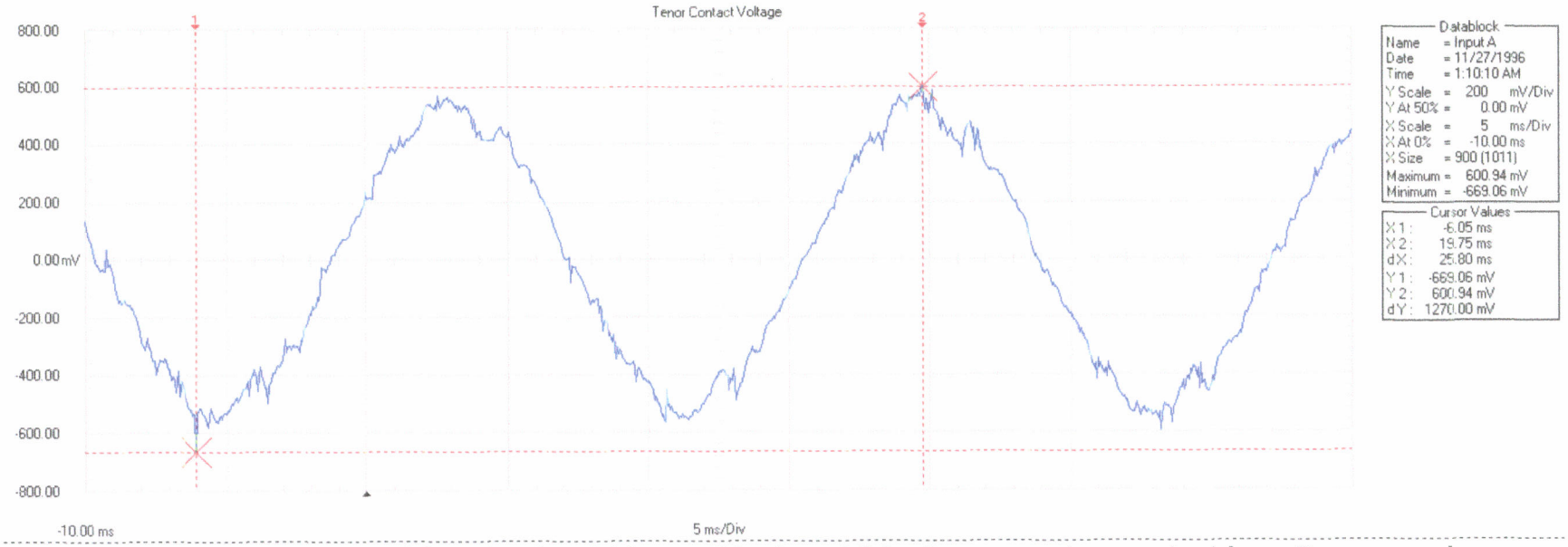
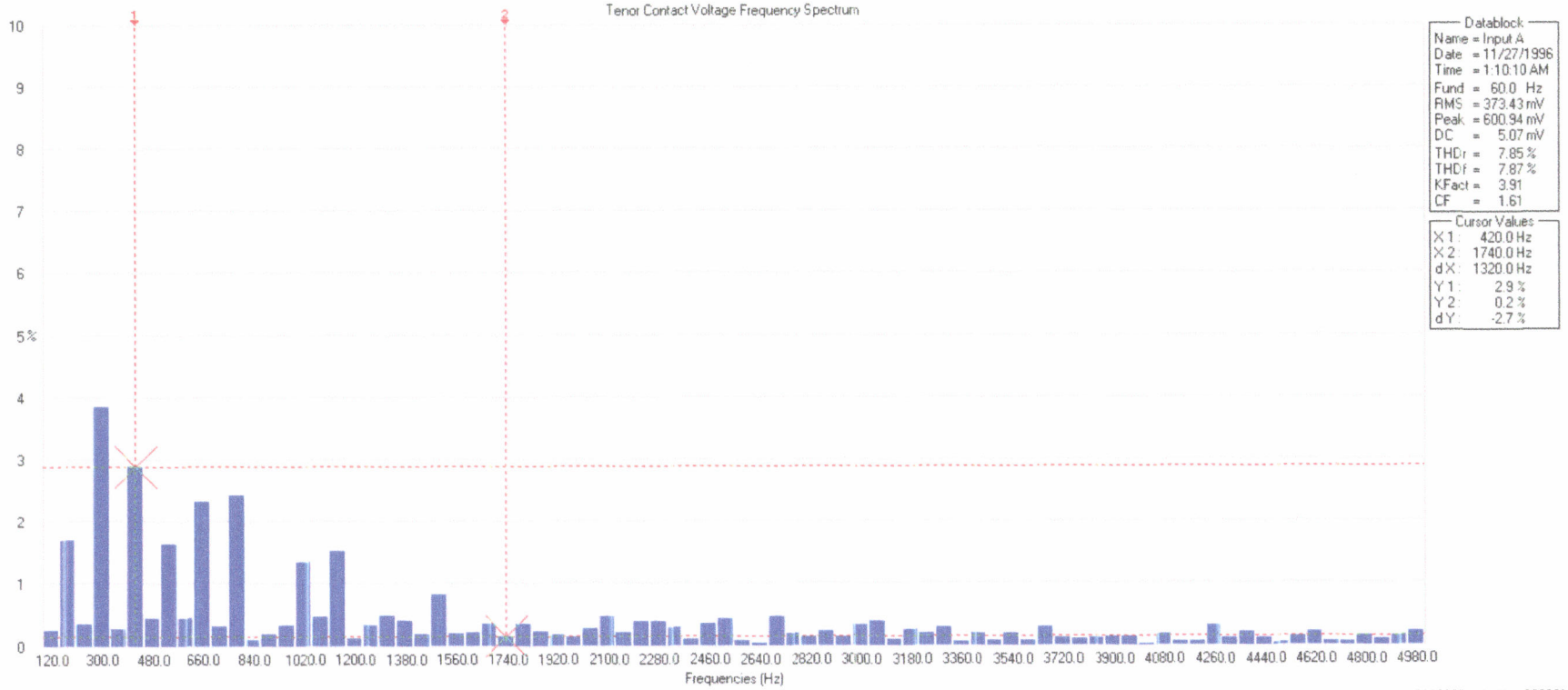


The above frequency spectrum is of a waveform collected between two remote ground rods in the yard of the Darrel and Sarah Cappelle home near Denmark, WI.

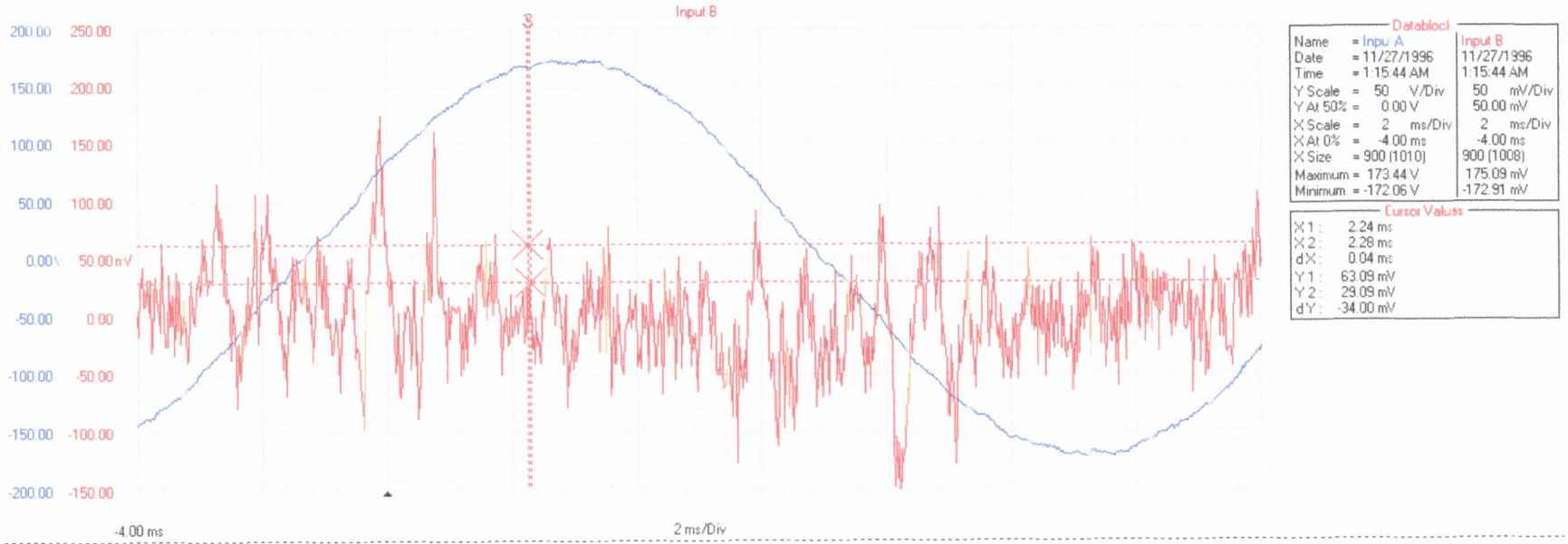
Tenor



The waveform was collected with a Fluke 199 Scopemeter at the Jean and Larry Tenor home. The leads were connected betweeen the kitchen sink and an EKG patch placed on the floor. (Contact Voltage) Assuming a person has an impedance of 500 Ohms, the contact current would be 2,540 micro amperes or more than 141 times the current the NIEHS states is relevant to cancer.



The above frequency spectrum is of a waveform collected between the sink and floor (contact Voltage) at the Tenor home near Denmark, WI.



The waveform was collected with a Fluke 199 Scopemeter at the Jean and Larry Tenor home. Channel A was connected to a 120V receptacle. Channel B was connected at the same potential except through the Graham ubiquitous filter (removes the 60 cycle). The area between the cursors represents a frequency of 25kHz. The high frequency is riding on the utility supplied 60 cycle waveform.

Summary

The data collected was the data present at the time of collection. It needs to be understood that these levels change with time and electrical usage. Several wind turbines were in operation at the time of testing. Long-term monitoring should be done while the wind turbines are in operation and also when they are not in operation. The data should then be compared to determine what contributions (of high frequency transients and harmonics) are attributable to the turbines.

David Stetzer

President
Stetzer Consulting, LLC

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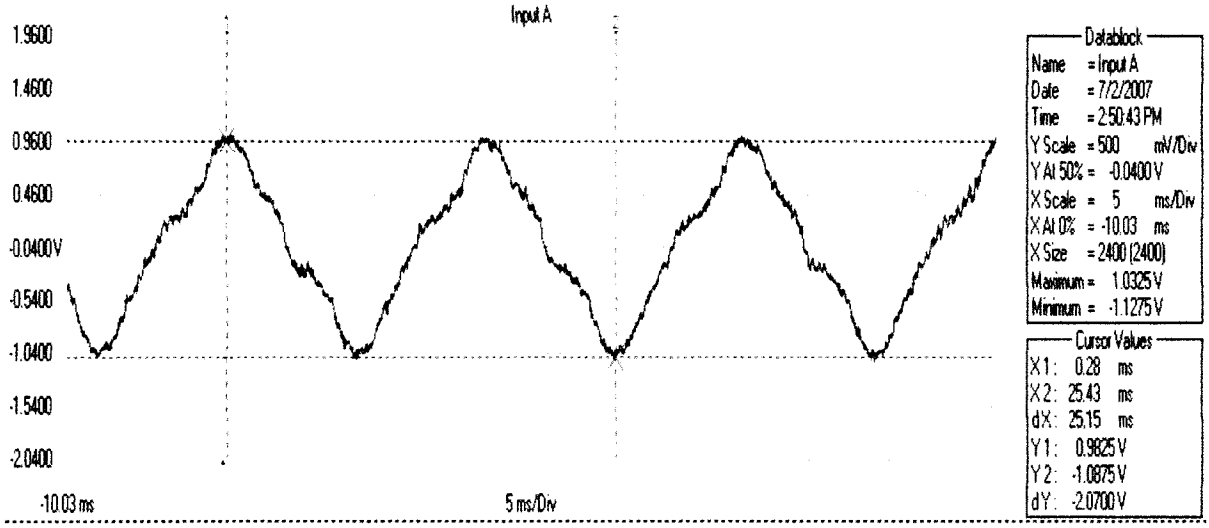
Modern Wind Turbines Generate Dangerously "Dirty" Electricity

By Catherine Kleiber
Waveforms and picture courtesy of David Colling

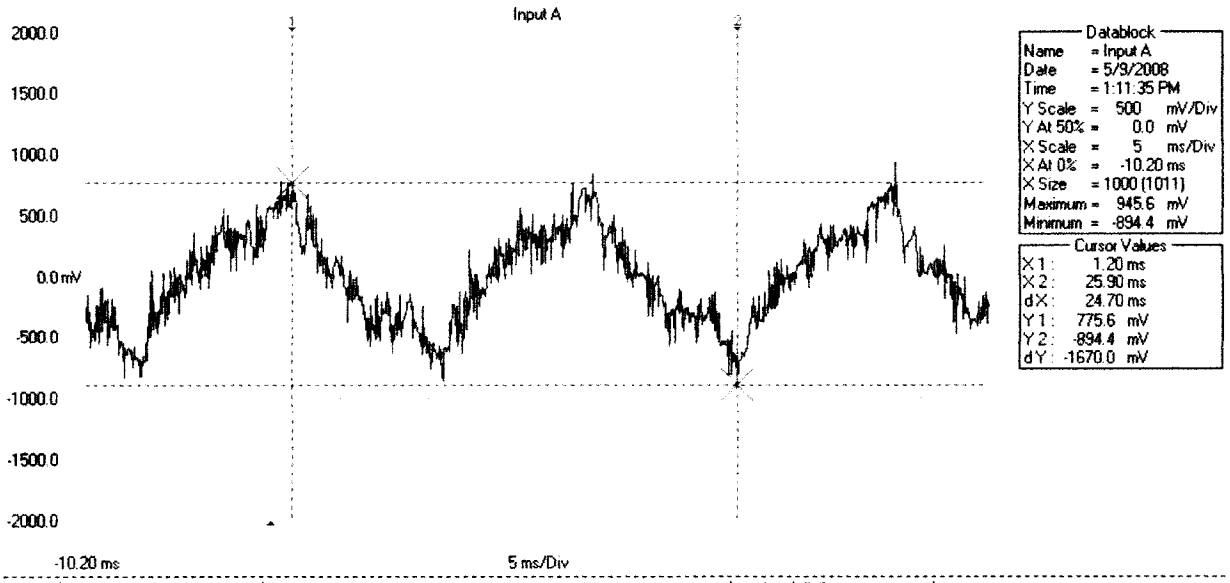
Wind turbines are causing serious health problems. These health problems are often associated, by the people having them, with the flicker and the noise from the wind turbines. This often leads to reports being discounted.

Residents of the area around the Ripley Wind Farm in Ontario where Enercon E82 wind turbines are installed feel that the turbines are making them ill. Residents suffer from ringing in the ears, headaches, sleeplessness, dangerously elevated blood pressure (requiring medication), heart palpitations, itching in the ears, eye watering, earaches, and pressure on the chest causing them to fight to breathe. The symptoms disappear when the residents leave the area. Four residents were forced to move out of their homes, the symptoms were so bad. Residents also complain of poor radio, TV and satellite dish reception. There is no radio reception under or near the power lines from the wind turbines because there is too much interference. Local farmers have found that they get headaches driving along near those power lines.

The waveforms below were taken at one of the residences in the area. The first waveform was taken before the wind farm started operation. (As you can see, a ground current problem existed even before the wind farm started.) The frequency profile of the neutral to earth voltage changed dramatically after the wind farm became operational (second waveform). There are far more high and very high frequencies present; indicated by the increased spikiness of the waveform.



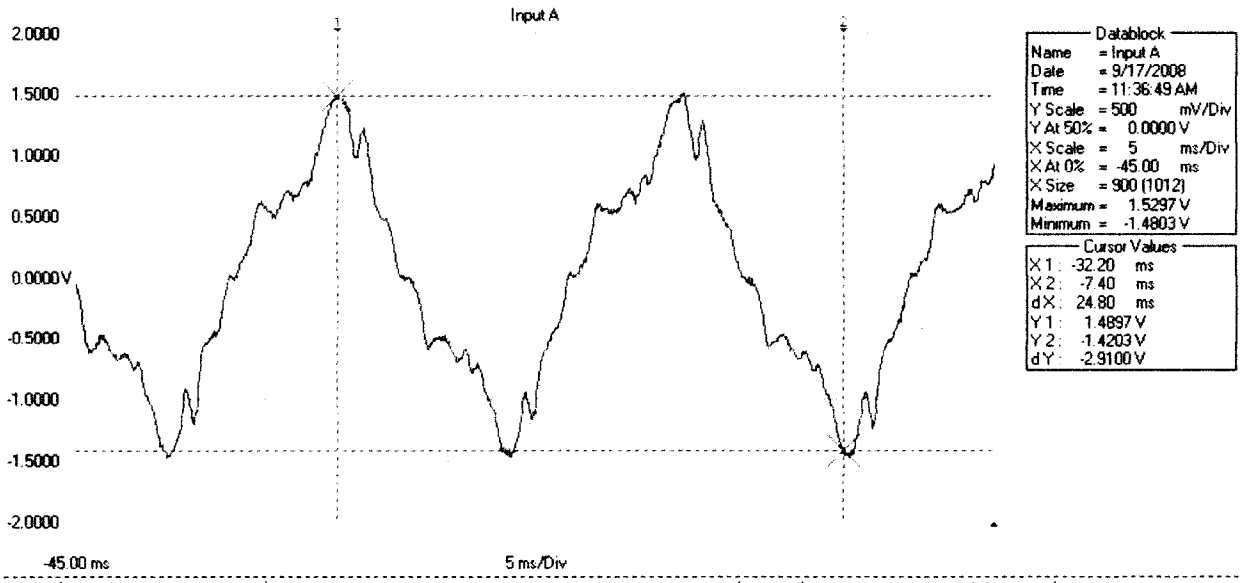
Residence #3, Primary Neutral to remote ground rod, before windmills were installed and running.



Residence #3, Primary Neutral to remote rod, windmills running before the collection line was buried.

As demonstrated by these waveforms, wind turbines are extremely electrically polluting. Studies and anecdotal reports associate electrical pollution with a similar set of symptoms to those experienced by the residents of the area.[1, 2, 3] The symptoms associated with electrical pollution are caused by overexposure to high frequencies and are known as radio wave sickness.[4] Technical papers discuss the fact that it requires only very small amounts of high frequency signals (either from transients or communications) on wiring to induce significant electrical currents in the human body. They support findings of human health problems caused by exposure to even small amounts of high frequencies.[5, 6] The specific symptoms experienced depend on both the frequencies present and the body type and height of the person being exposed. Increased risk of cancer is associated with exposure to both "dirty" power on wires and electrical ground currents.[7, 8] Animals also experience health problems related to electrical pollution exposures. Dairy cow's milk production and health suffers as exposure to high frequency transients increases.[9, 10]

Suncor and Acciona have tried to some degree to correct the problem at the Ripley Wind Farm. They buried the collector line from the turbine near some of the most badly affected homes and gave the homes a separate distribution line. They also put an insulator between the neutral line and the grounding grid for the wind farm. As you can see, from the waveform below, it helped somewhat. It reduced the high frequencies being induced on the distribution system by the proximity of the collectors and the high frequencies put directly on the neutral by the tie to the wind farm grounding grid. However, it is still not as good as before the wind farm installation and neither is their health.



Residence #3, Primary Neutral to remote rod, windmills on, collection line now buried.

This is not the only wind farm that seems to be causing serious health problems for local residents. The Enercon E82 does not seem to be unique in its design or problems. Wind turbines generate a sine wave of variable frequency in order to be able to take advantage of the full range of wind speeds. However, the grid only operates at 60Hz, so the variable frequency is converted to DC and then an inverter is used to convert the DC signal to 60 Hz AC. This is the signal that is put on the power line. Most inverters generate an extremely "dirty" signal, which is a 60Hz waveform polluted with a lot of high frequency transients. The previous waveforms are examples of this. The people in this house were so sick at home with the wind turbines running that they had to abandon their home and move elsewhere while they waited for the problem to be fixed. The changes made by the wind farm combined with a neutral isolation device installed by the homeowners has made the home livable, but their health is still affected by the operation of the wind turbines.

In order to eliminate the electrical pollution problem wreaking havoc on the health of people living in proximity to wind farms, the inverters need to be properly filtered at each wind turbine and all collection lines from the wind turbines to the substation should be buried. At the substation the electricity must also be filtered before being allowed on the power grid. There also needs to be a proper neutral system installed to handle the high frequency return current.

More information about electrical pollution and health can be found at www.electricalpollution.com. The author can be contacted with questions about electrical pollution at webmaster@electricalpollution.com.

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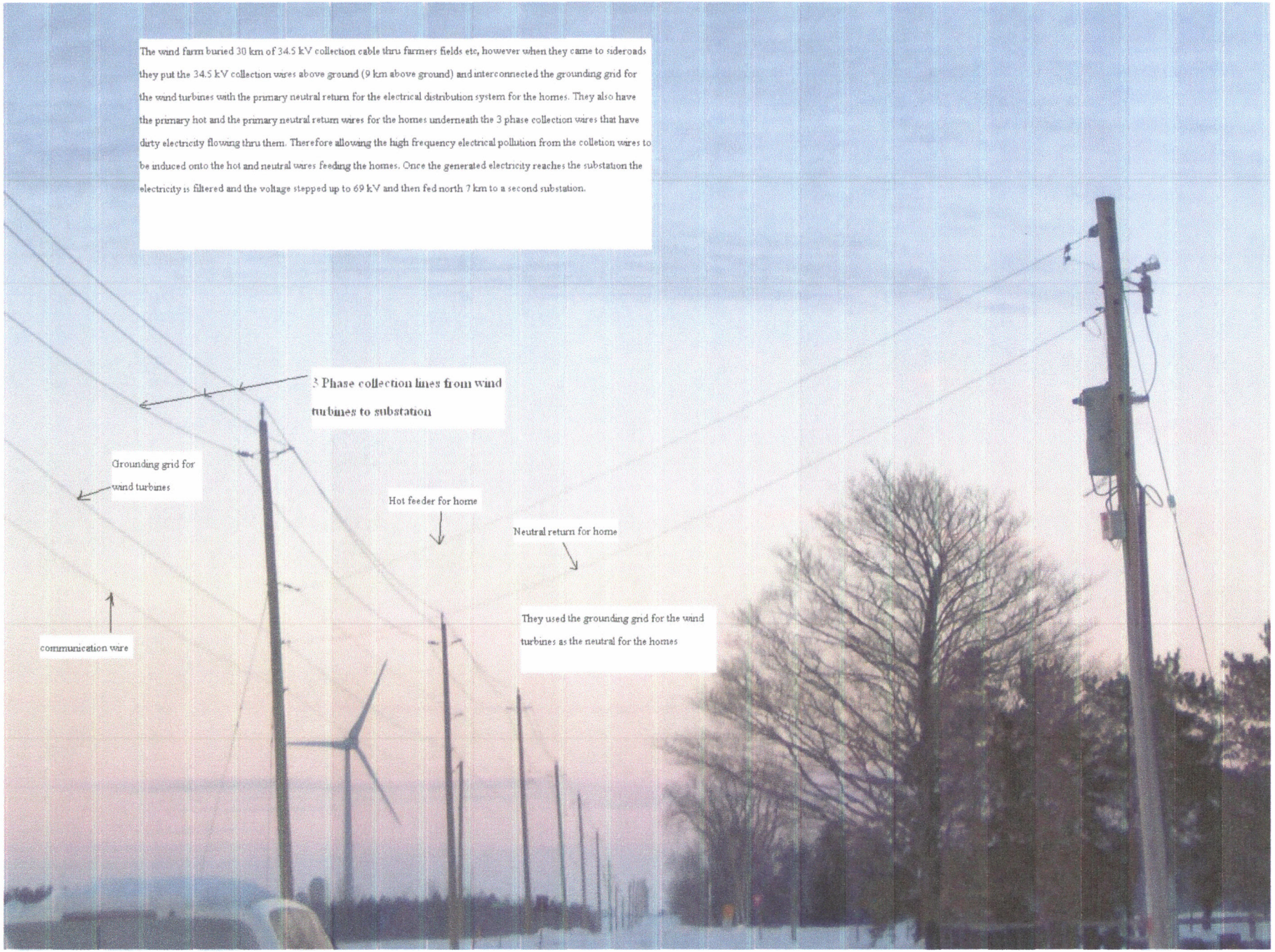
The wind farm buried 30 km of 34.5 kV collection cable thru farmers fields etc, however when they came to sideroads they put the 34.5 kV collection wires above ground (9 km above ground) and interconnected the grounding grid for the wind turbines with the primary neutral return for the electrical distribution system for the homes. They also have the primary hot and the primary neutral return wires for the homes underneath the 3 phase collection wires that have dirty electricity flowing thru them. Therefore allowing the high frequency electrical pollution from the colletion wires to be induced onto the hot and neutral wires feeding the homes. Once the generated electricity reaches the substation the electricity is filtered and the voltage stepped up to 69 kV and then fed north 7 km to a second substation.
3 Phase collection lines from wind turbines to substation
Grounding grid for wind turbines
Hot feeder for home
Neutral return for home
communication wire
They used the grounding grid for the wind turbines as the neutral for the homes

Ground Current Investigation

Otho, IA and Pomeroy, IA

David Stetzer

Stetzer Consulting, LLC

Introduction

In August 2013, I was contacted by David Olson of Otho, IA to investigate the possibility of a wind farm near Pomeroy, IA contributing to a "stray voltage"[1] problem affecting the health of area residents. In August 2013, I agreed to go to Otho and Pomeroy, IA and take measurements at several homes and other locations in the area.

This report, resulting from my work near the communities of Otho and Pomeroy, IA will provide 1) a brief history regarding the issue of ground currents/voltages, 2) information from published research on ground currents/voltages, and 3) data collected during my testing at area homes showing that a high frequency ground current/voltage issue is present.

History

In 1972 there was an oil embargo that forced countries to become more energy efficient. Energy efficient lightning, variable speed frequency drives, electronic motor starters, light dimmer switches, as well as a host of other electronic loads were rapidly being connected to the electrical grid. These devices use current in short pulses that create harmonics and high frequencies transients on the electrical circuits. Prior to this time the majority of the loads were linear loads. With Linear loads the current was drawn in a continuous manner. The electrical grid was designed for only 60-cycle linear loads like light bulbs and motors and not for the high frequency producing electronic loads that were being added rapidly after 1972. Most electric utilities have not updated their obsolete lines to handle the technological load that started being connected to their system in the late 70's and continues to date. The electric utility's primary neutral wire that was designed to bring the unbalanced current back to the substations was, and still is, no longer capable of handling the excess current and higher than 60-cycle currents now riding on the wire. The wire has too much impedance (opposition to AC current) due to its inadequate size, which causes overheating and a buildup of voltage on the wire called Primary Neutral to Earth Voltage (PNEV). The Institute of Electrical and Electronics Engineers (IEEE) recognized the problems caused by these changing loads and adopted a national standard, the IEEE-519, in 1981. The IEEE revised the standard in 1986, and again in 1992. It was a problem that was recognized and addressed by industry worldwide, except for most electric utilities. It became the topic of most power quality magazines and publications throughout the industry. For example, in the June 1999 issue of Electrical

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[1] The term "stray voltage" was coined by electric utilities and public utilities commissions. The word "stray" infers that no one is responsible. There may be stray dogs and stray cats; it may be unknown where they come from or where they are going. Voltage, on the other hand, does not stray; it is governed by scientific laws (Ohm's Law, Kirchhoff's Law, etc.) and it goes where people put it. Therefore, in this report we will refer to this problem as ground currents/ voltages, and not "stray voltage".

Construction and Maintenance (EC&M) Magazine, Ken Michaels wrote, "Harmonics: It surfaced as a buzzword in the early 1980's, ...".

From the IEEE (1996) Guide for Applying Harmonic Limits on Power Systems:

> When single phase electronic loads are supplied with a 3-phase, 4-wire circuit, there is a concern for the current magnitudes in the neutral conductor. Neutral current loading in the 3-phase circuits with linear loads is simply a function of the load balance among the three phases. With relatively balanced circuits, the neutral current magnitude is quite small. This has resulted in a practice of under sizing the neutral conductor in relation to the phase conductors.
>
> With electronic loads supplied by switch-mode power supplies, the harmonic components in the load currents can result in much higher neutral current magnitudes. This is because the odd triplen harmonics (3, 9, 15, etc.) produced by these loads show up as zero sequence components for balanced circuits. Instead of canceling in the neutral (as is the case with positive and negative sequence components), zero sequence components add together in the neutral conductor. The third harmonic is usually the largest single harmonic component in single phase power supplies or electronic ballasts. (p. 63)

Glen A. Mazur, in his 1992 technical manual Power Quality Measurement and Troubleshooting, stated:

> Triplen harmonics do not cancel, but add together in the neutral conductor. In systems with many 1-phase nonlinear loads, neutral current can exceed an individual phase current. Generally, the amount of neutral current is between 125% and 225% of the highest phase current. The third harmonic current is usually responsible for most of the neutral current because the third harmonic typically represents the harmonic with the highest current value. High neutral current is dangerous because it causes overheating in the neutral. Because there is no CB in the neutral conductor to limit current, as in the phase conductors (A, B, and C), overheating of the neutral can become a fire hazard.

Because of the increased and higher frequency currents on the utilities' primary neutral, the electric utilities decided to use the earth as a return path to their substations for the excess currents they are responsible for. Once the currents are in the earth, they flow uncontrolled over the surface, across private property, into homes and barns, and through humans and animals. This was done despite national standards and electrical safety codes, as evidenced in the IEEE's National Electrical Safety Code book under Rule 92D, which states, "Ground connection points shall be arranged so that under normal circumstances there will be no objectionable flow of current over the grounding conductor" (1996, p. 16).

Also regarding objectionable flow of current, the IEEE's NESC Handbook, Fourth Edition (1996) tells us that:

> Such flow may be disturbing to the service, as is sometimes the case around dairy barns in which cows are connected to milking systems. ...installations

> near areas that are often known to present specific problems (such as milking barns without adequate voltage gradient control, pipelines, electric railways, conduits, etc.) may need special attention to limit damage to equipment or uncomfortable conditions for personnel or animals. (p. 30)

In 1991, the United States Department of Agriculture (USDA) published a report entitled "Effects of Electrical Voltage/Current on Farm Animals". Within this report is a section on the electrical power system of the United States, which tells us:

> The U.S. electrical power system is a huge network and is based on a specific transmission, distribution, and utilization philosophy. When consumer equipment consisted primarily of lights, motors, and tube-type electronic equipment, and electrical loads were relatively small, neutral-to earth voltages and transients were not great problems, due to the lower neutral currents and the tolerance of the equipment. With increasing use of low-signal-level solid-state computers and microprocessors, increasing electrification and automation of farms, and increased loads on distribution lines, the issue of power quality and tolerable neutral-to-earth voltage is becoming increasingly important. It will become necessary in the future to more clearly specify the power characteristics that the utility is to provide at the delivery point, the limits to which a consumer's type of usage can he allowed to affect other customers and the utility, and who is to monitor and require conformance to the specifications. The ramifications of meeting these needs are that difficult economic, technical, and legal problems will arise and will have to be solved. (p. 6-2)

A subsequent section on electrical system load growth says:

> The increase in neutral currents and leakage or uncleared fault currents to earth due to electrical load growth...along a distribution line can lead to an increase in the neutral-to-earth voltage. (p. 6-3)

It should be noted that the electric utilities did not create the high frequencies present on their distribution lines due to consumer load growth. The manufacture and use of electronic equipment created the problem, and the electric utilities inherited it. However, the electric utilities are responsible for what is on their lines and for putting the current into the earth, thus allowing currents to flow uncontrolled over the earth's surface. To reiterate - from the first footnote in this report - the term "stray voltage" was coined by electric utilities and public utilities commissions. The word "stray" infers that no one is responsible. There may be stray dogs and stray cats; it may be unknown where they come from or where they are going. Voltage, on the other hand, does not stray; it is governed by scientific laws (Ohm's Law, Kirchhoff's Law, etc.) and it goes where people put it.

Initial Observations and Testing

After arriving in Iowa, I met with David Olson and Jason Stanek, who escorted me to several local residences where they had arranged for me to conduct testing. These local residents believe their families' health problems are directly related to the operation of recently energized wind turbines.

Relying on my extensive experience with diagnosing and troubleshooting electrical problems, and power quality issues in particular, I expected to find distorted 60 cycle sine waves riddled with high frequency transients and harmonics during my testing in the Otho and Pomeroy, IA area. This was, in fact, the case with every measurement I collected, whether from connection points at an area home's kitchen sink to kitchen floor, at utility primary neutral to earth voltage to a remote ground rod, or between two remote ground rods in a resident's yard.

The issue affecting these area residents is that of high frequency ground currents/ voltages, known to many as "stray voltage", or, more properly, electrical pollution (in the case of electrical equipment) and electrical poisoning (in the case of humans and animals). Electrical and electronics engineering societies, utilities, governments, and many other organizations have researched this issue for decades, and trade publications and newspaper articles have addressed this issue for more than the past decade.

Marek Samotyj, EPRI's (Electrical Power Research Institute) manager for power quality stated in a July 5, 1999 Fortune magazine article, "Hot New Technologies for American Factories", "[t]he quality situation will get worse before we will be able to mitigate it . . . One reason is that EPRI [Electrical Power Research Institute] expects 70% of all electricity produced within the U.S. to flow through electronic devices by 2002, vs. 30% today" (Bylinski, p. 4)

An article by Beck Ireland in the September 2006 edition of EC&M, "Clearing up Confusion on Unwanted Voltages", highlights numerous incidents of "stray voltages" affecting humans, animals, and electric utilities, including:

- East Village, NY, 2004: Jodie S. Lane, a 30-year-old Columbia University graduate student, was killed when she stepped on a metal plate.
- Feb 12, 2006: Four people shocked by service box near Port Authority Bus Terminal.
- Feb 17, 2006: Dog electrocuted on patch of concrete in Park Slope Brooklyn
- March 2006: Nine-year old boy hospitalized after an electric jolt while walking over a metal plate in Harlem.
- March 2006: New York City's Consolidated Edison found 1,214 instances of stray voltage during a year-long examination of electrical equipment on city streets.
- Con Ed expects to spend $100 million this year [2006] toward reducing the risk of stray voltage.

More recent evidence of this issue can be found in a Toronto Sun newspaper article, "Children Shocked by Stray Voltage", where Don Peat reports, "Several children shocked by stray voltage - just two weeks after a second dog was electrocuted - has finally prompted Toronto Hydro to mobilize 600 workers to inspect its aging street-level infrastructure" (January 30, 2009).

The issue of ground current has been addressed not only in consumer publications, but also in electrical industry engineering manuals, code books and other published guidelines. For example, the Wiley Encyclopedia of Electrical and Electronics Engineering, Volume 8 (1999), states, "It is an unsafe practice to allow current to flow over the earth continuously, uncontrolled. All continuously flowing current must be contained within insulated electrical conductors". Also, in a 2006 white paper "BC Hydro Deals With Farm Neutral to Earth Voltage", David M. Rogers, an Agricultural Specialist for BC Hydro, states:

> The Canadian Electrical Code Rule 10-200 states that concerning "The Rule (for grounding and bonding conductors) does not intend there be current flowing through the bonding and grounding system during normal operation." Its Subrule (3) of Chapter 10-200 states that: "Where by using multiple grounds objectionable flow of current occurs over the grounding conductor:
>
> - One or more of the grounds shall be abandoned;
> - The location of the grounds shall be changed;
> - The continuity of the conductor between the grounding connections shall be suitably interrupted;
> - Other effective action shall be taken to limit the current." (p.3)

According to Rogers (2006), BC Hydro has developed a positive approach to dealing with the issue of ground currents/voltages, ultimately producing positive results for both Canadian farmers and BC Hydro, including, 1) a reduction in mastitis in farms at any one time from 230 in 1997 to fewer than 20 in the period from 2003 to 2006, and, 2) never having had a legal suit over farm ground current/voltage issues (p. 13).

With regard to wind turbines contributing to ground currents/voltages, I will offer this information. IEEE Std. 519-1992 states:

> The emergence of renewable, alternate energy sources has resulted in the use of many varied topologies as power conditioners or inverters for utility tied operation. These inverters are available in single-phase units and in three-phase units, and their outputs may be very clean sinusoids with near unity power factor or may contain various characteristic and noncharacteristic harmonics and power factors that may cause unacceptable power quality on the electric utility grid or interfere with its controls or relays. (p. 23)

To summarize, this issue has been well-publicized and well-documented.

After my initial meeting with David and Jason, we proceeded to several locations near Pomeroy, IA to conduct testing; this included one area home and several other locations. After testing was completed near Pomeroy, we proceeded to the David Olson and Jason Stanek homes near Otho, IA. At each home I used a Fluke 199 two-channel Scopemeter to collect readings from 1) kitchen sink to kitchen floor, 2) a kitchen electrical receptacle, and 3) two remote ground rods in residents' front yards. Measurements between remote ground rods were not taken at the Stanek residence, as data collected in other locations had provided sufficient data for our purposes. The measurement results are presented below following a brief commentary.

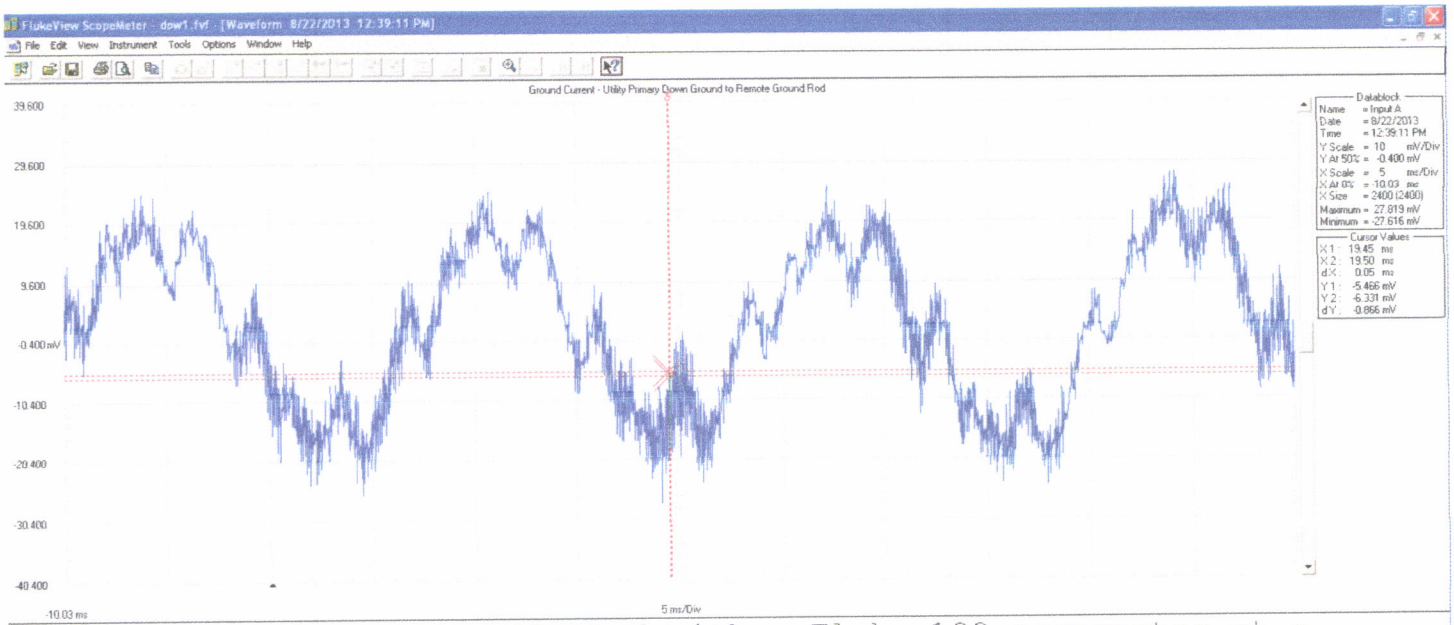
My research into the issue of ground currents/voltages, spanning more than the past decade, has allowed me to gather a vast library of information in the form of books, industry publications and codes, peer-reviewed journal articles, scientific experiments, etc. I will provide here a few pertinent statements to keep in mind while reviewing the following data.

1) Frequencies above 1.7 kHz dissipate internally to the human body (Reilly, 1992).
    - Frequency spectrums of the collected waveforms show that residents in these locations are exposed to frequencies well in excess of 1.7 kHz.
2) "...the absolute (as well as the modest) level of contact current modeled (18 uA) produces average electric fields in tissues along its path that exceed 1mV/m. At and above this level, the NIEHS Working Group [1998] accepts that biological effects relevant to cancer have been reported in numerous well-programmed studies" (Kavet, 2000).
    - Analysis of collected waveforms indicates that residents in test locations are exposed to anywhere from 16 to 291 times this amount of current.
3) Symptoms of Microwave and Radio-Frequency Radiation (excerpted from NMRI, 1972)

- Headaches
- Heart Palpitations/ Arrhythmia
- Fatigue
- Muscle spasms
- Weakness
- Insomnia
- Digestive problems
- Anxiety
- Depression
- Altered sugar metabolisms (Diabetes)
- Sinusitis
- Nausea
- Deteriorating Vision
- Difficulty concentrating
- Memory Loss
- Muscle & joint pain

- Breathing Difficulties

Figure 1.

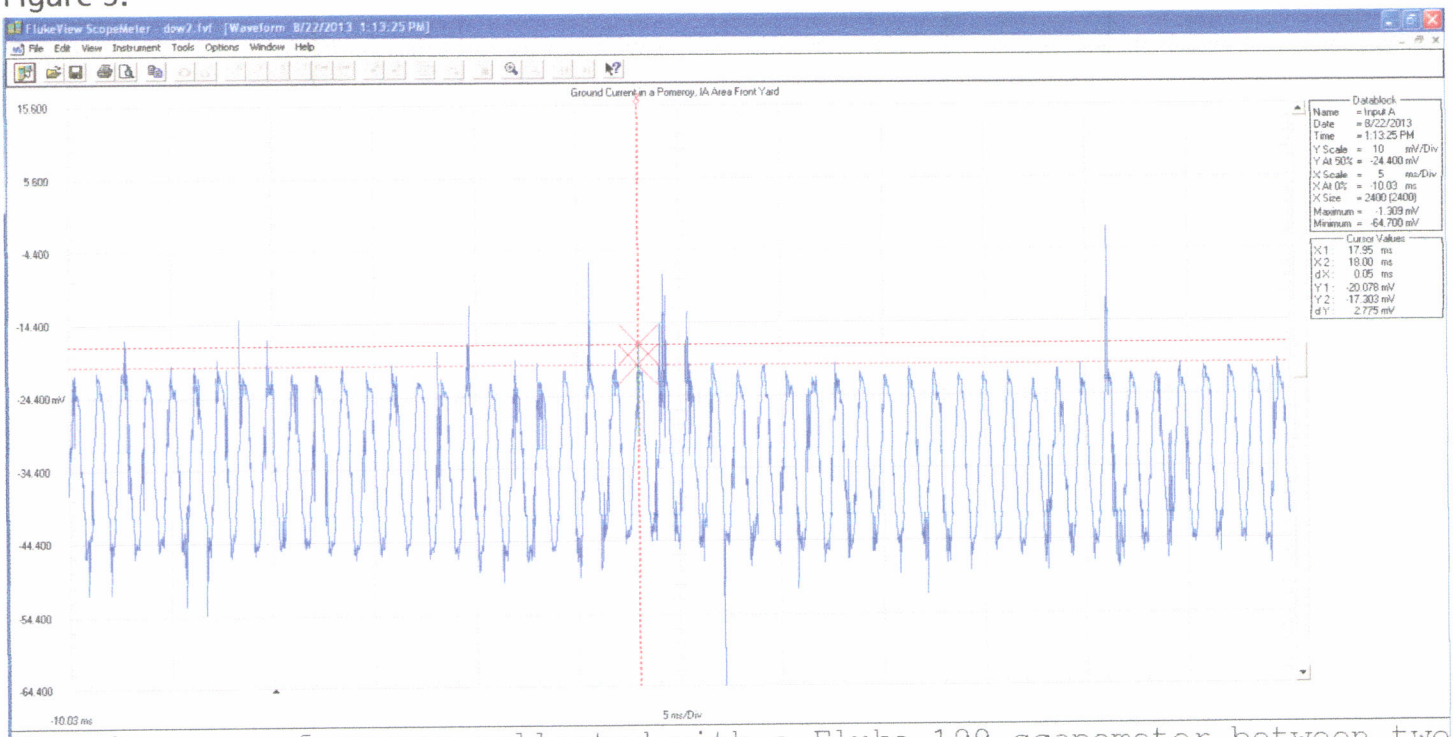


The above waveform was collected with a Fluke 199 scopemeter at a utility pole approximately 1/4 mile south of the Highway 4/7 junction near Pomeroy, IA (next to the Kalsow Prairie State Preserve sign). Channel A was connected between the primary down ground at the utility pole and a remote ground rod. The area between the cursors represents a frequency of 20 kHz.

Figure 2.

The above frequency spectrum is of a waveform collected between a utility primary down ground and a remote ground rod.

Figure 3.

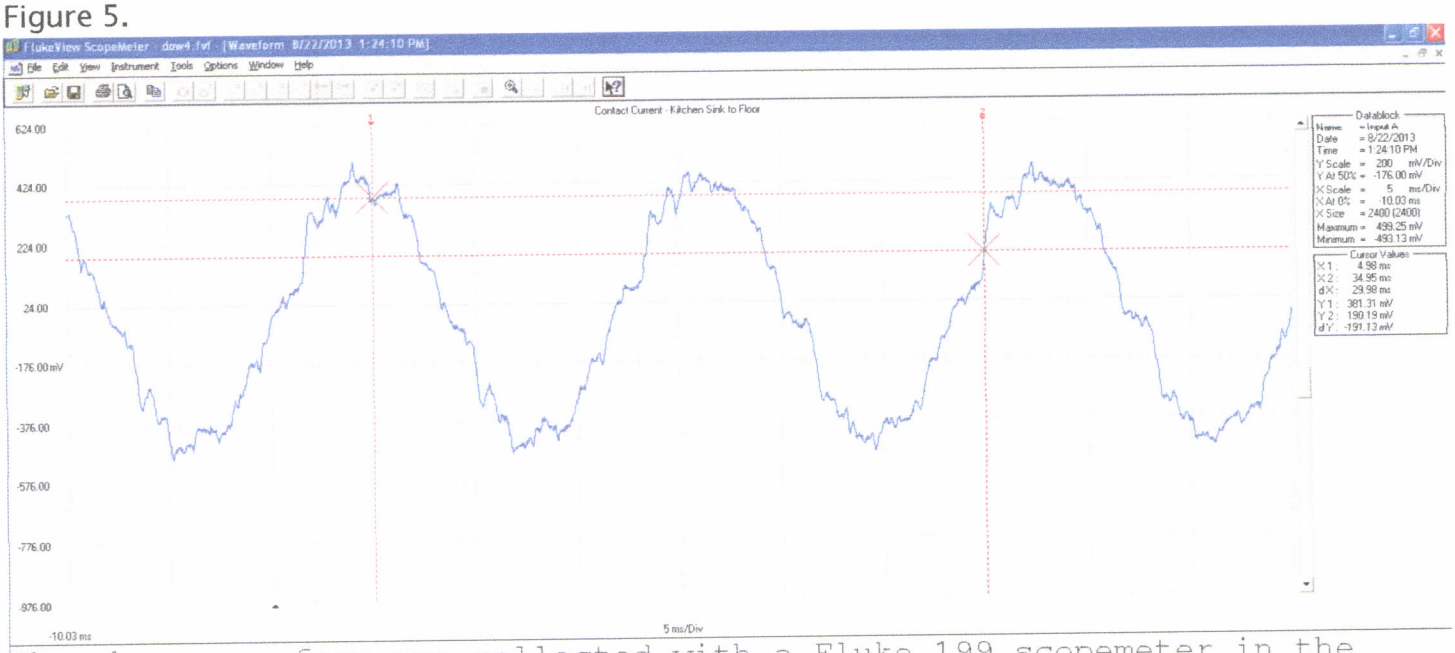


The above waveform was collected with a Fluke 199 scopemeter between two remote ground rods in the front yard of Mike Holtapp near Pomeroy, IA. The area between the cursors represents a frequency of 20 kiloHertz.

Figure 4.

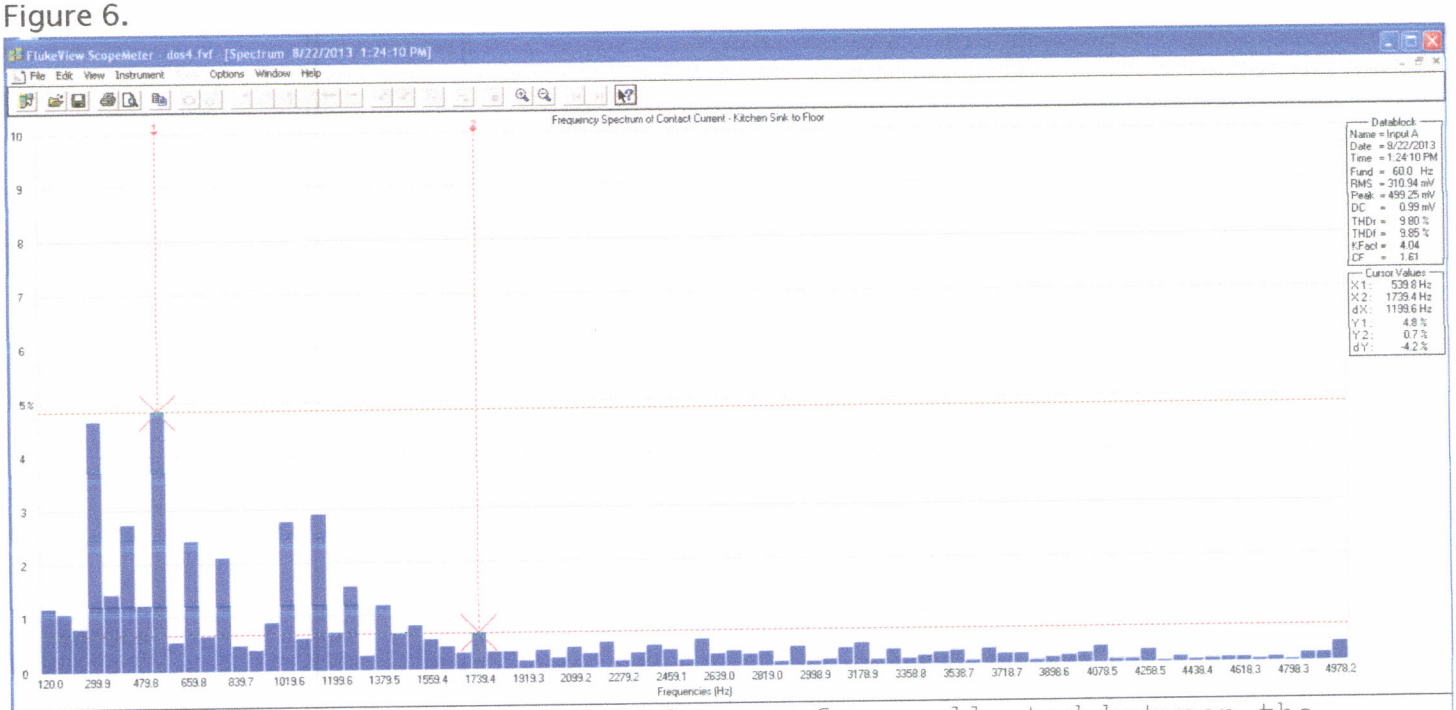
The above frequency spectrum is of a waveform collected between two remote ground rods in the front yard of the Mike Holtapp residence near Pomeroy, IA. Energy above 1.7 kiloHertz (Cursor 2) will dissipate internal to the human body.

Figure 5.



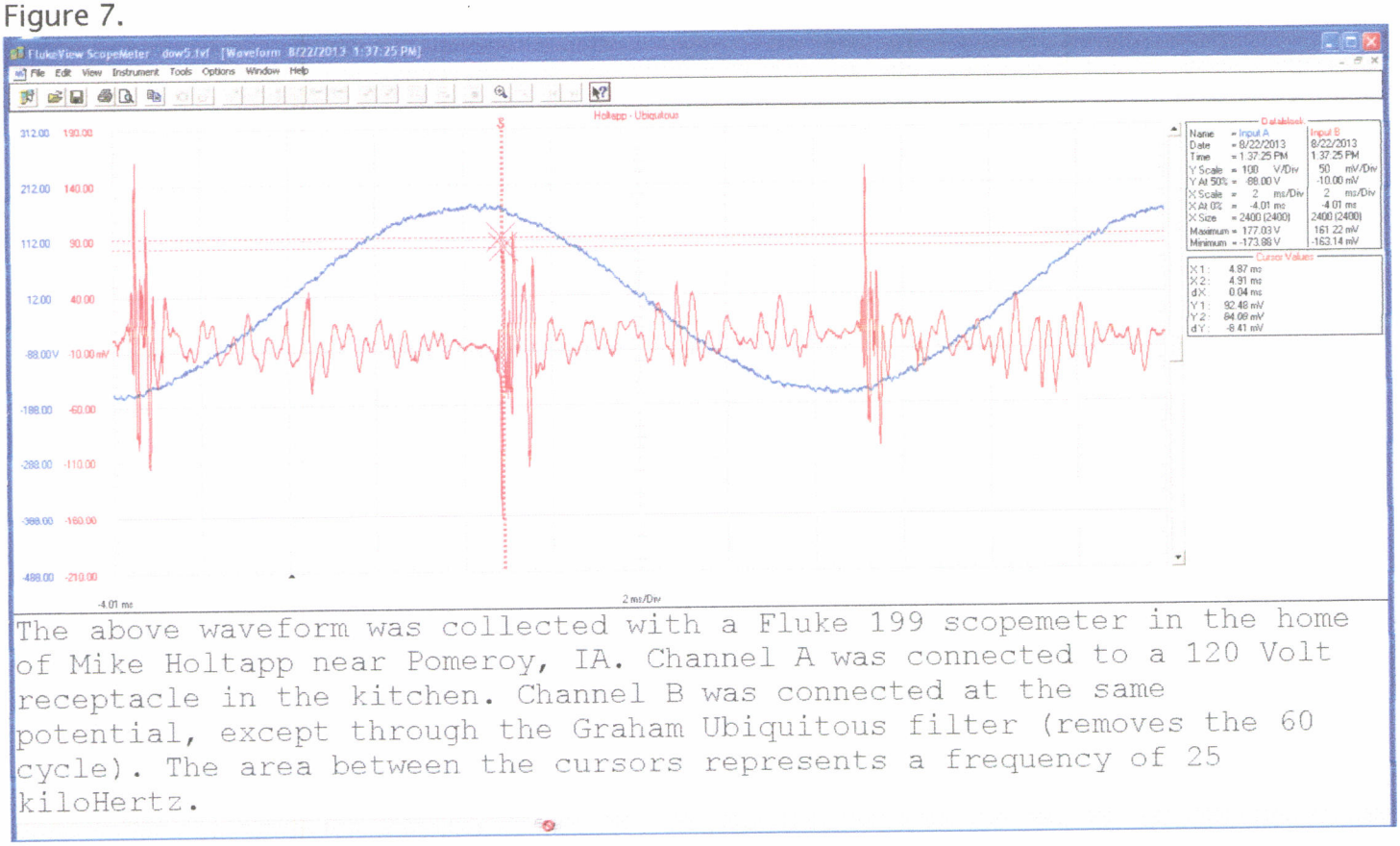
The above waveform was collected with a Fluke 199 scopemeter in the home of Mike Holtapp near Pomeroy, IA. Channel A was connected between the kitchen sink and an EKG patch placed on the floor in front of the sink. Assuming a person has an impedance of 500 Ohms, the contact current would be 1984 microamperes - more than 110 times the current the NIEHS states is relevant to cancer.

Figure 6.



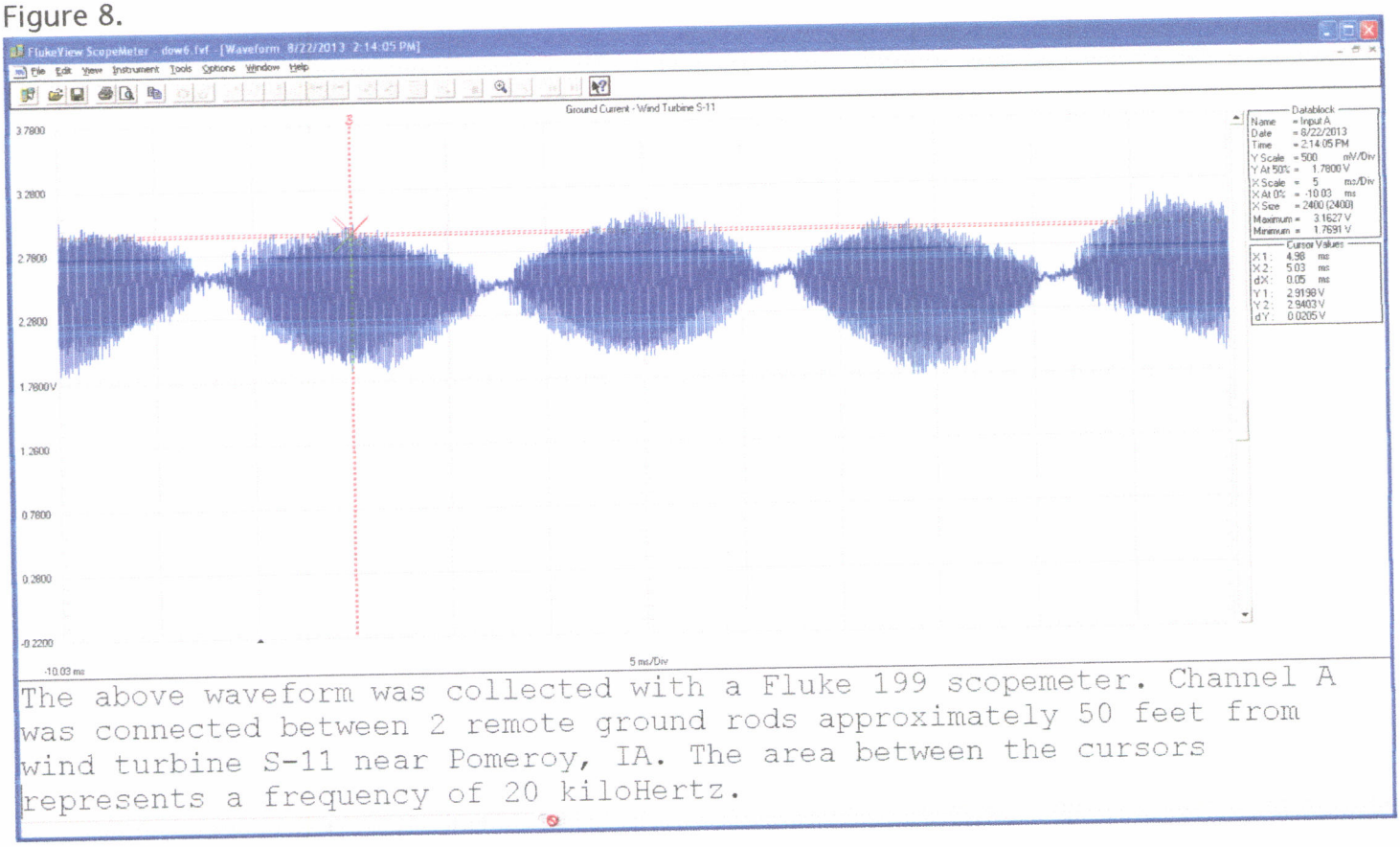
The above frequency spectrum is of a waveform collected between the kitchen sink and floor in the Mike Holtapp home near Pomeroy, IA. Energy above 1.7 kiloHertz (Cursor 2) will dissipate internal to the human body.

Figure 7.



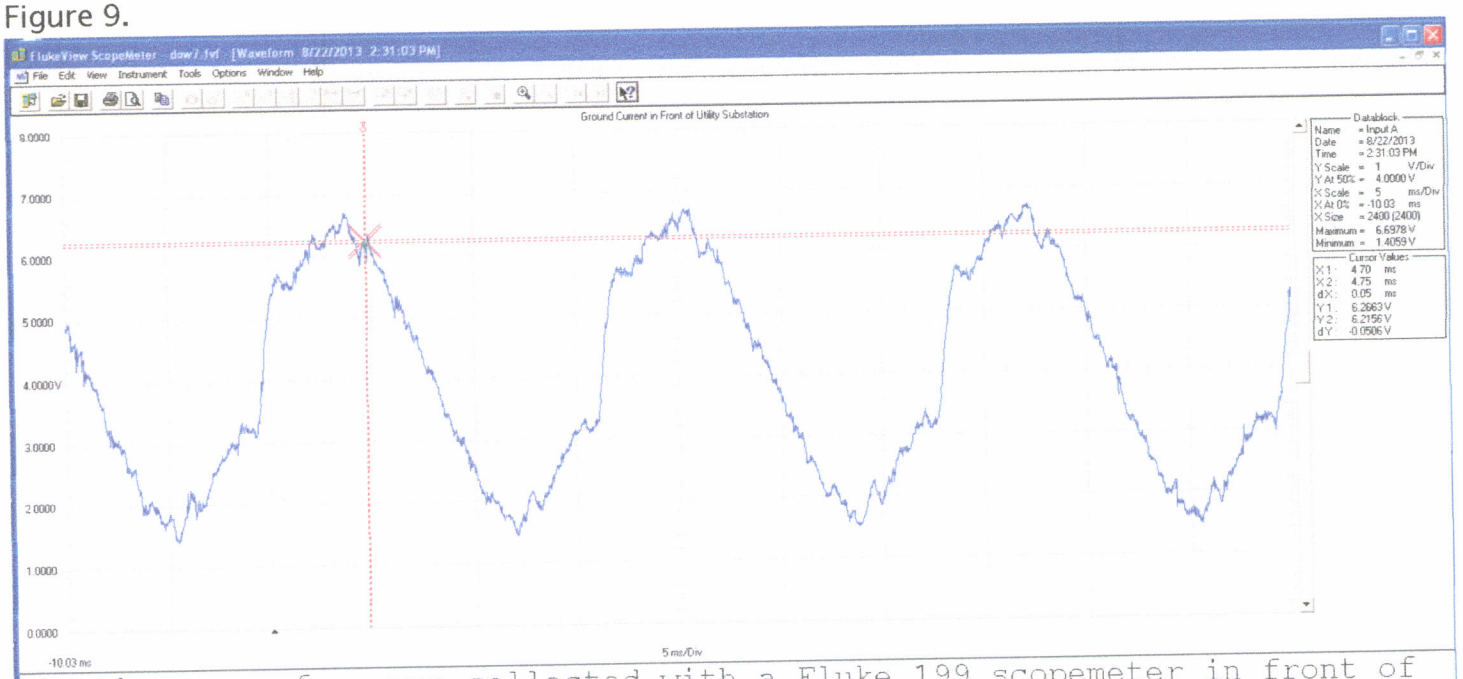
The above waveform was collected with a Fluke 199 scopemeter in the home of Mike Holtapp near Pomeroy, IA. Channel A was connected to a 120 Volt receptacle in the kitchen. Channel B was connected at the same potential, except through the Graham Ubiquitous filter (removes the 60 cycle). The area between the cursors represents a frequency of 25 kiloHertz.

Figure 8.



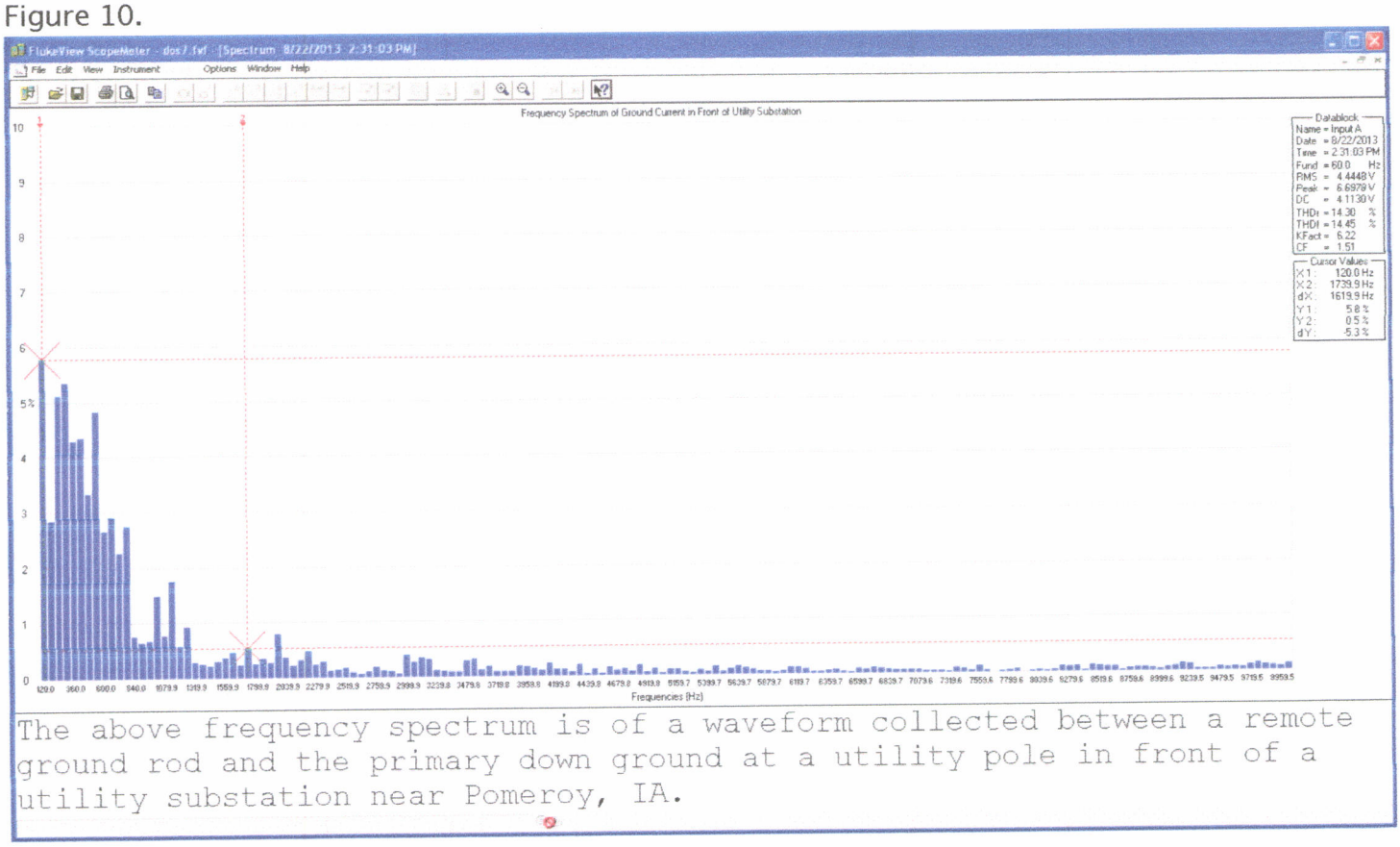
The above waveform was collected with a Fluke 199 scopemeter. Channel A was connected between 2 remote ground rods approximately 50 feet from wind turbine S-11 near Pomeroy, IA. The area between the cursors represents a frequency of 20 kiloHertz.

Figure 9.



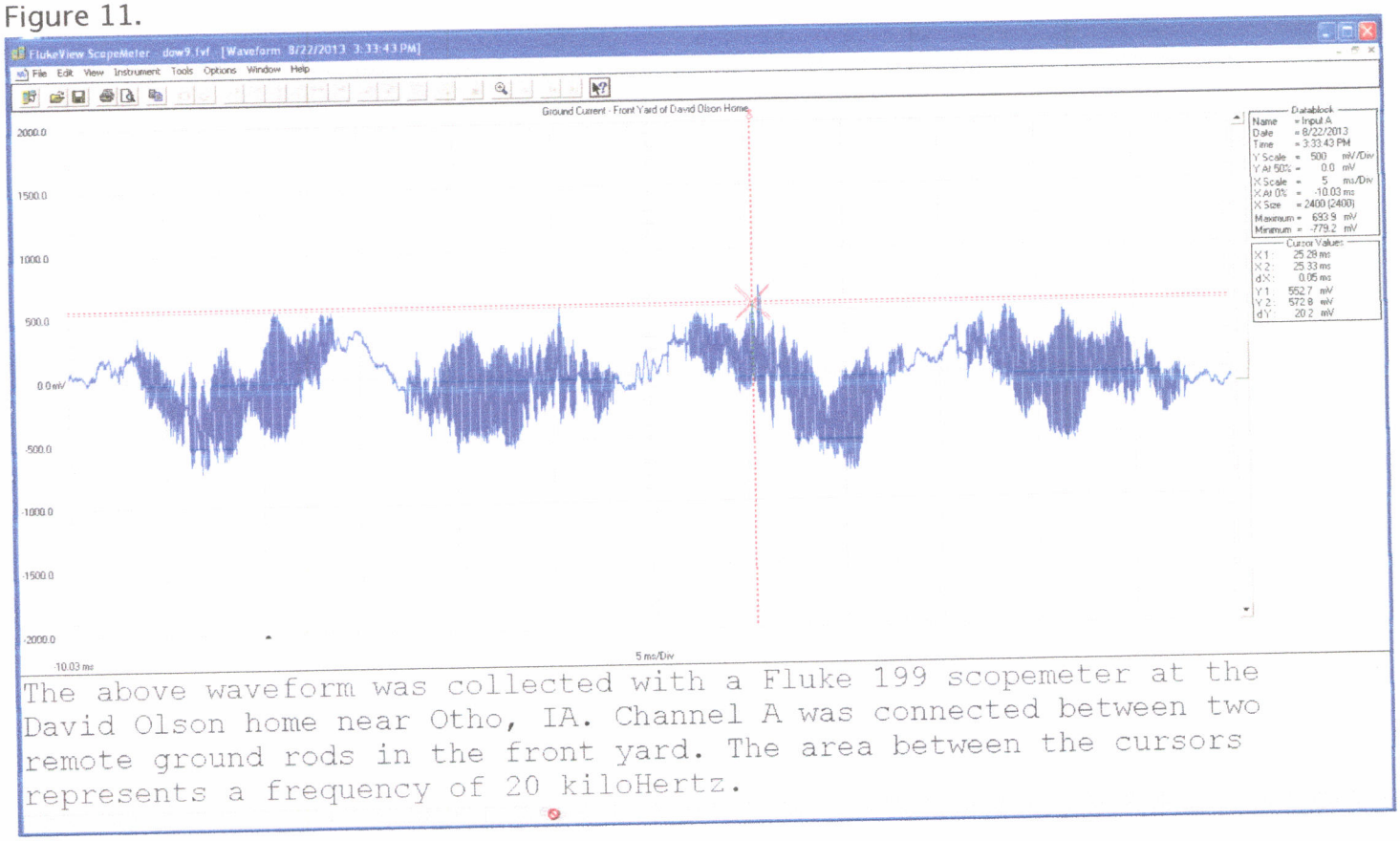
The above waveform was collected with a Fluke 199 scopemeter in front of a utility substation near Pomeroy, IA (63568 180th Ave). Channel A was connected between the primary down ground at a utility pole and a remote ground rod across the road (perpendicular to utility lines). The area between the cursors represents a frequency of 20 kiloHertz.

Figure 10.



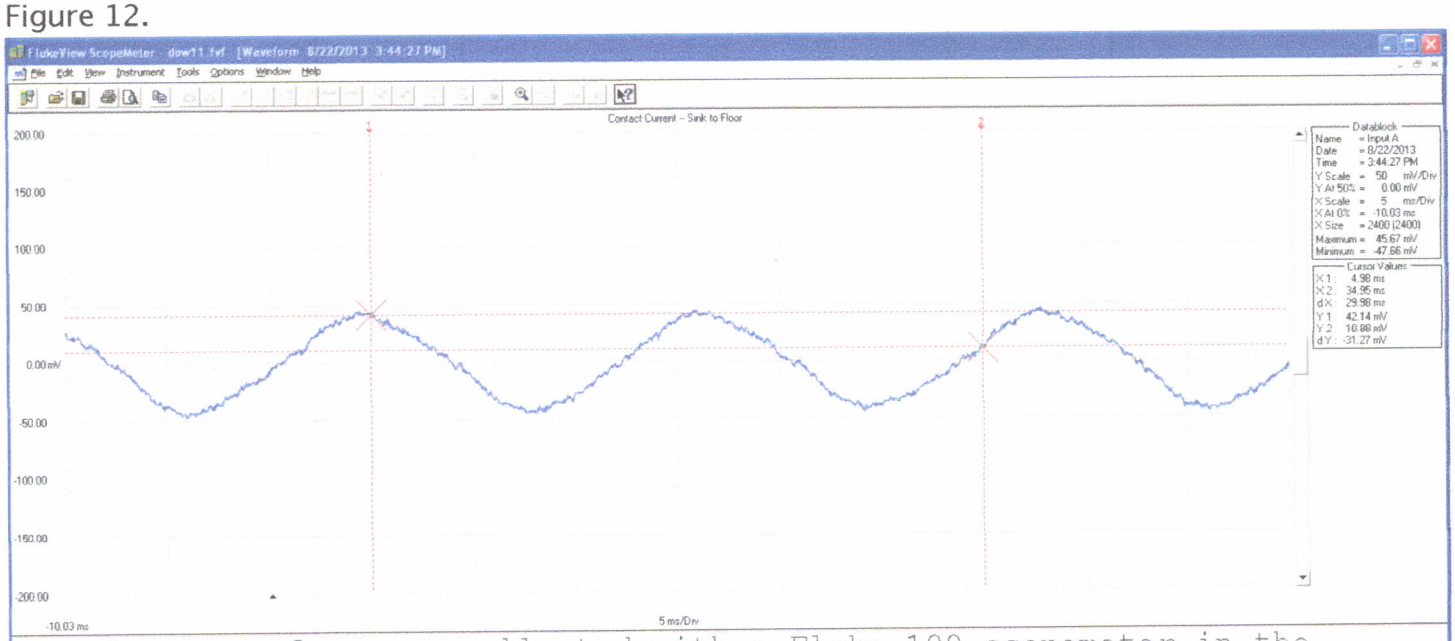
The above frequency spectrum is of a waveform collected between a remote ground rod and the primary down ground at a utility pole in front of a utility substation near Pomeroy, IA.

Figure 11.



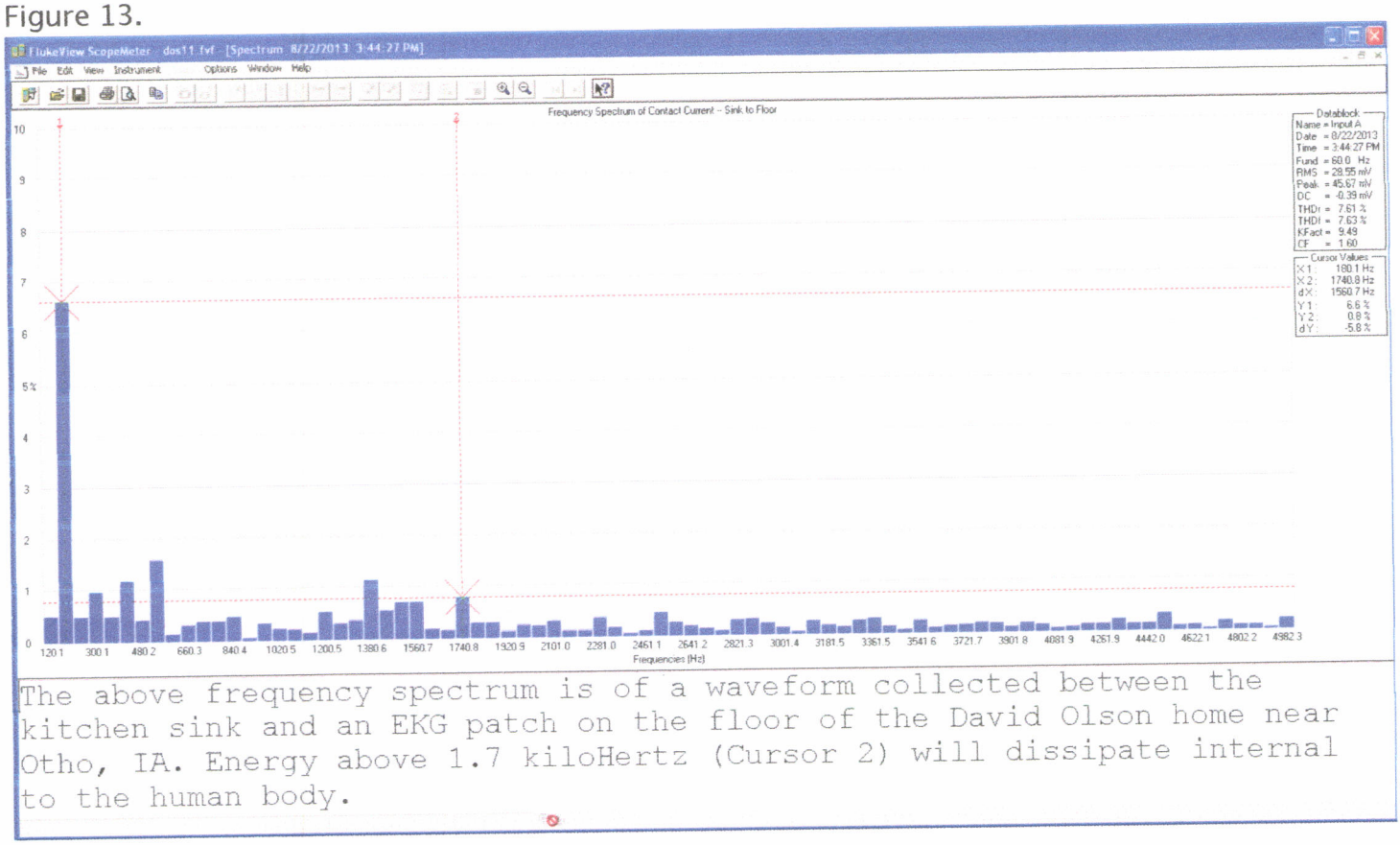
The above waveform was collected with a Fluke 199 scopemeter at the David Olson home near Otho, IA. Channel A was connected between two remote ground rods in the front yard. The area between the cursors represents a frequency of 20 kiloHertz.

Figure 12.



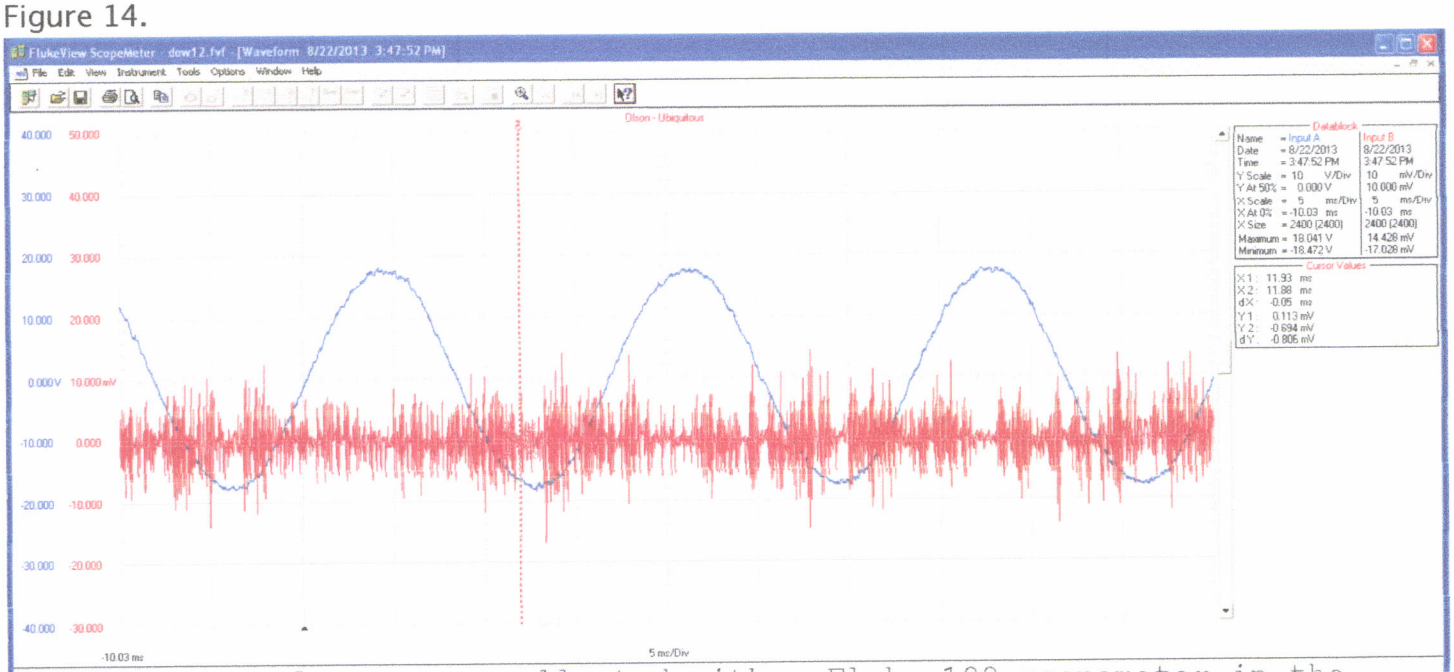
The above waveform was collected with a Fluke 199 scopemeter in the David Olson home near Otho, IA. Channel A was connected between the kitchen sink and an EKG patch placed on the kitchen floor. Assuming a person has an impedance of 500 Ohms, the contact current would be 186 microamperes - more than 10 times the current the HIEHS states is relevant to cancer.

Figure 13.



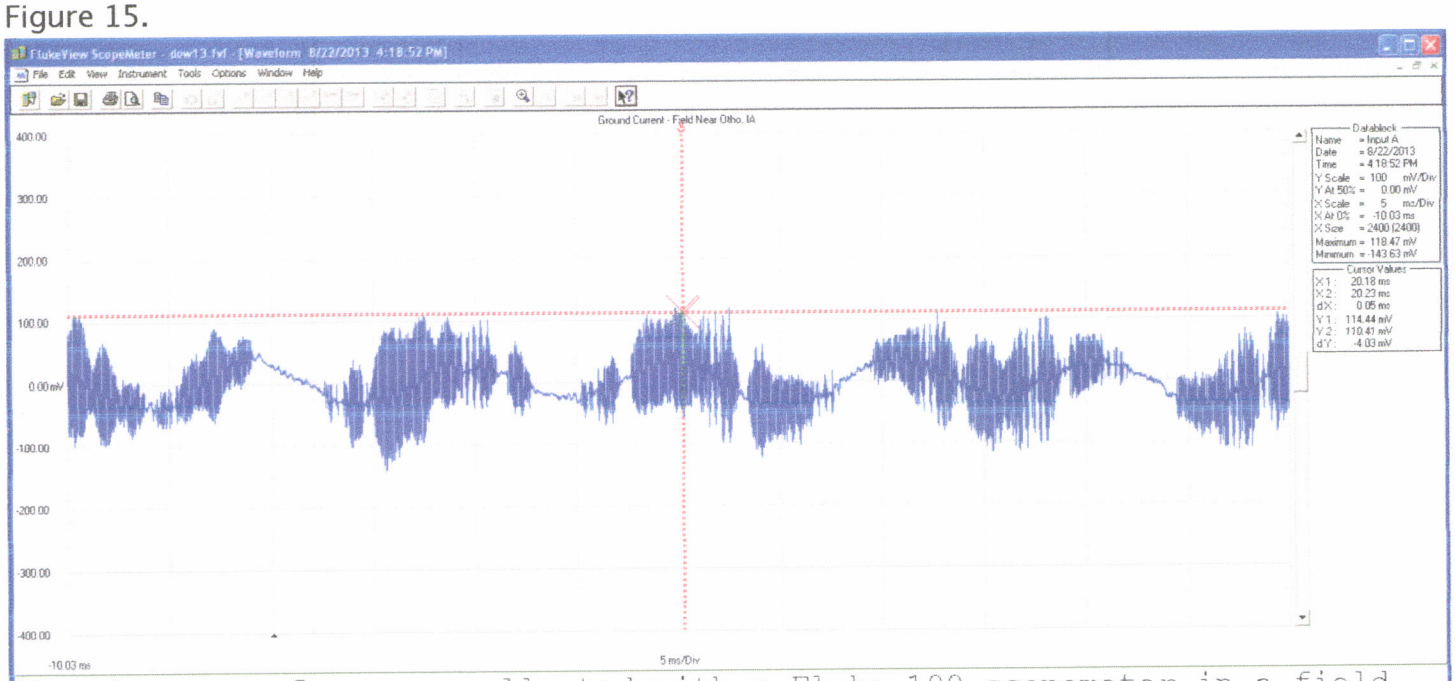
The above frequency spectrum is of a waveform collected between the kitchen sink and an EKG patch on the floor of the David Olson home near Otho, IA. Energy above 1.7 kiloHertz (Cursor 2) will dissipate internal to the human body.

Figure 14.



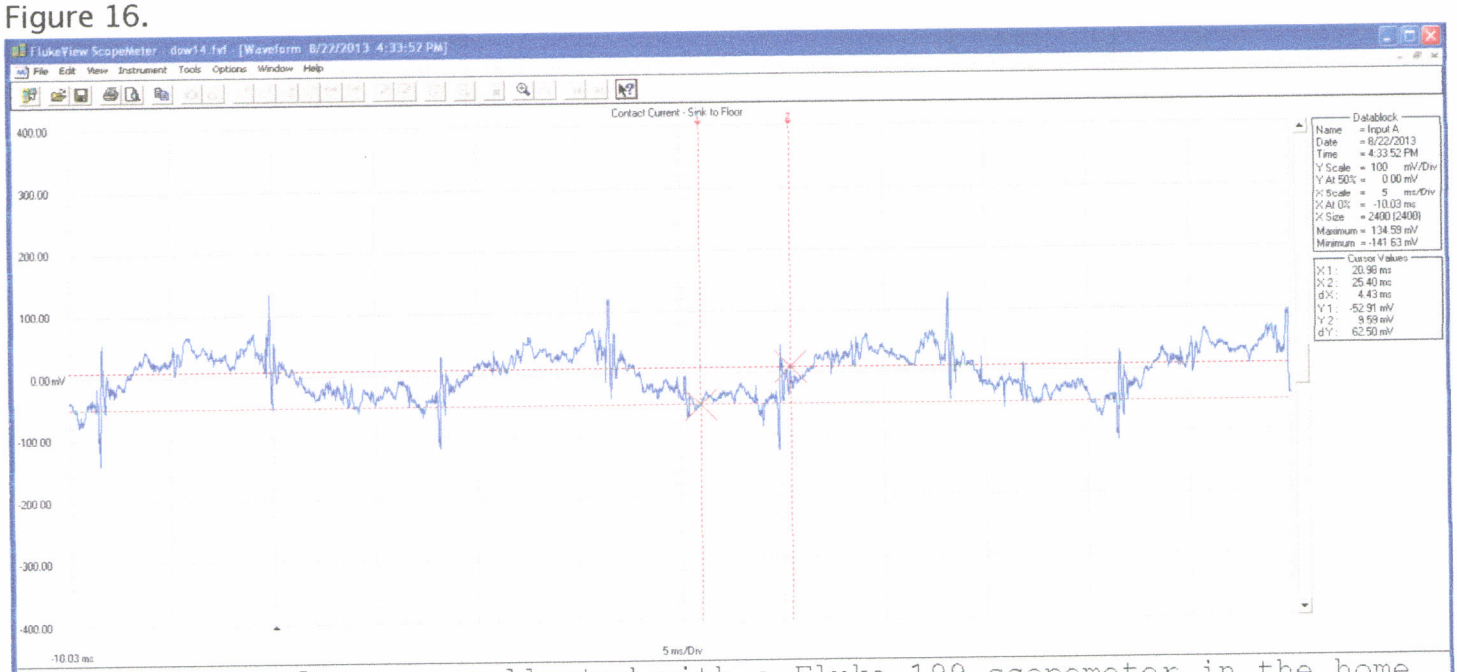
The above waveforms were collected with a Fluke 199 scopemeter in the David Olson home near Otho, IA. Channel A was connected to the 120 volt power supply. Channel B was connected at the same potential except through a Graham Ubiquitous filter (removes the 60 cycle). The area between the cursors represents a frequency of 20 kiloHertz.

Figure 15.



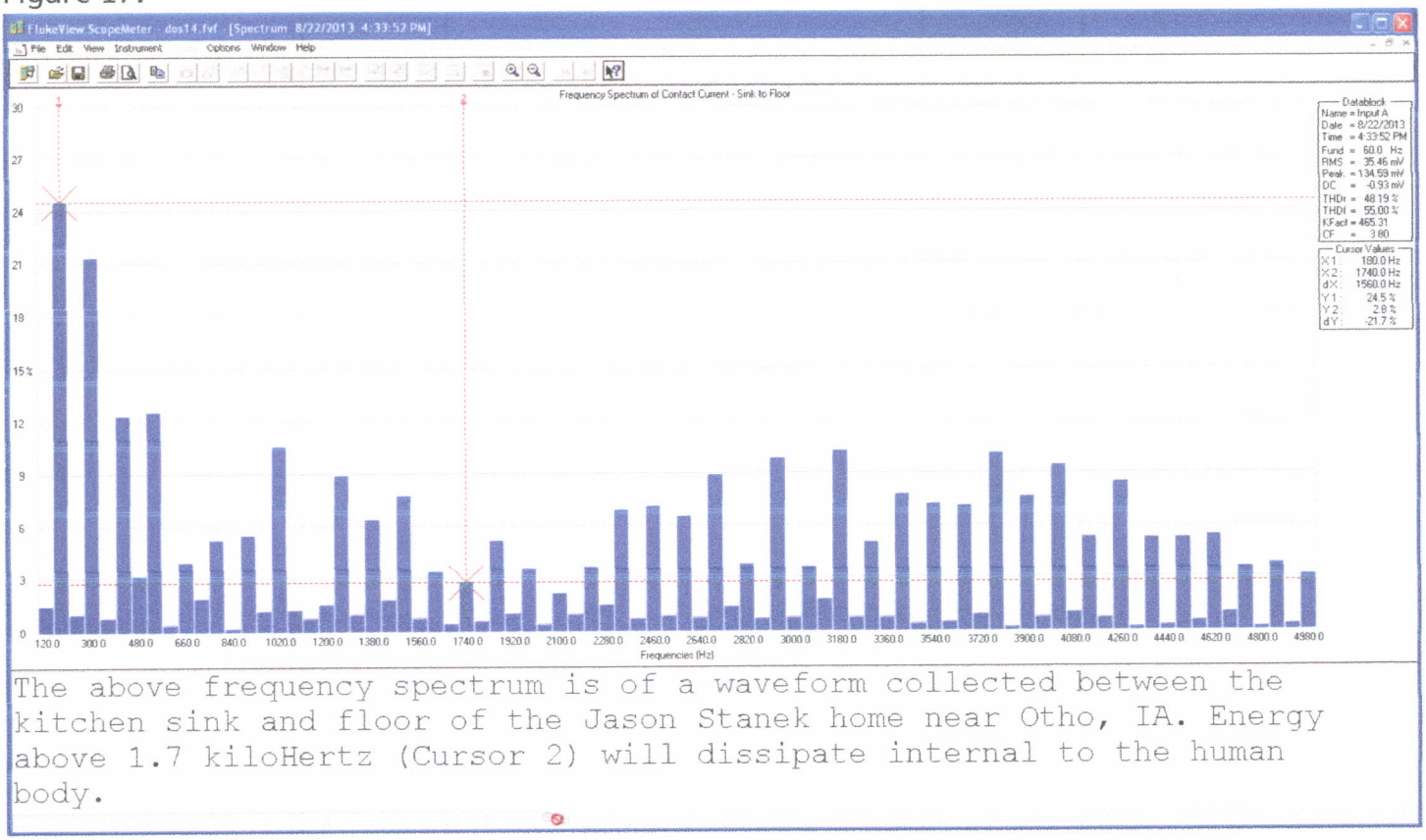
The above waveform was collected with a Fluke 199 scopemeter in a field approximately 1/2 mile east of the David Olson home near Otho, IA. Channel A was connected between 2 remote ground rods. The area between the cursors represents a frequency of 20 kiloHertz. The majority of the current is flowing in a North-south direction.

Figure 16.



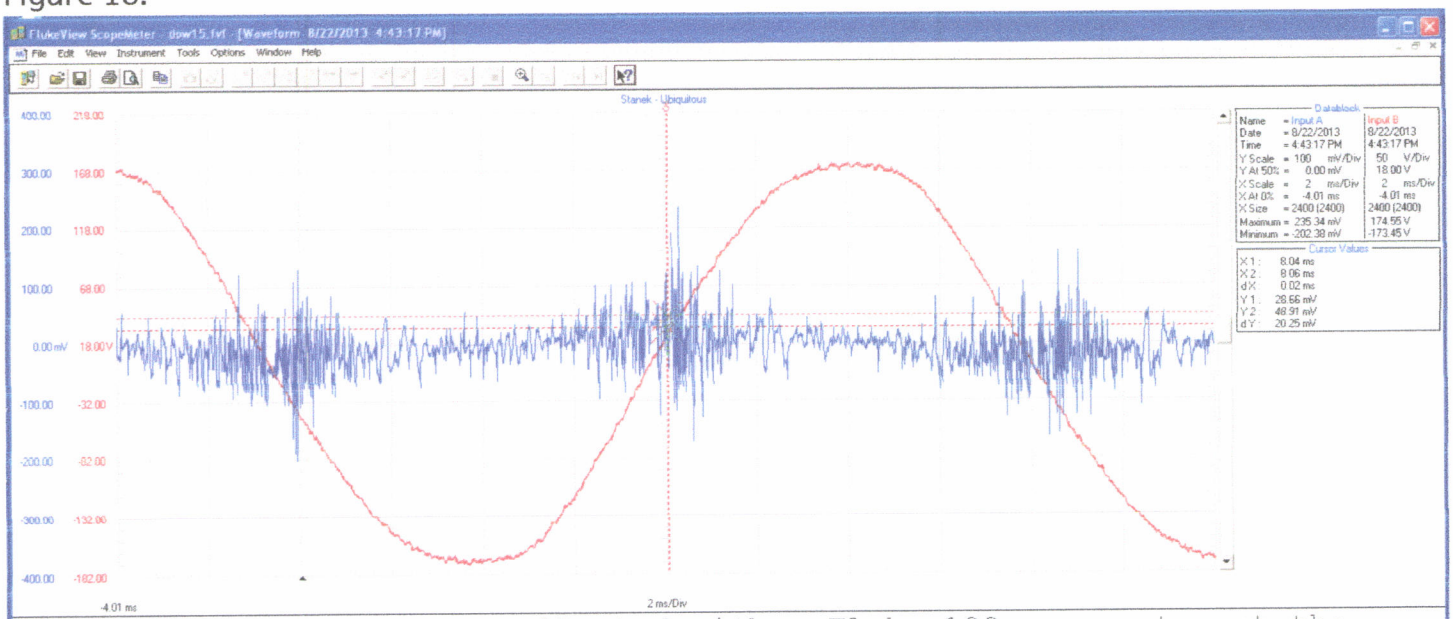
The above waveform was collected with a Fluke 199 scopemeter in the home of Jason Stanek near Otho, IA. Channel A was connected between the kitchen sink and an EKG patch on the floor. Assuming a person has an impedance of 500 Ohms, the contact current would be 552 microamperes - more than 30 times the current the NIEHS states is relevant to cancer.

Figure 17.



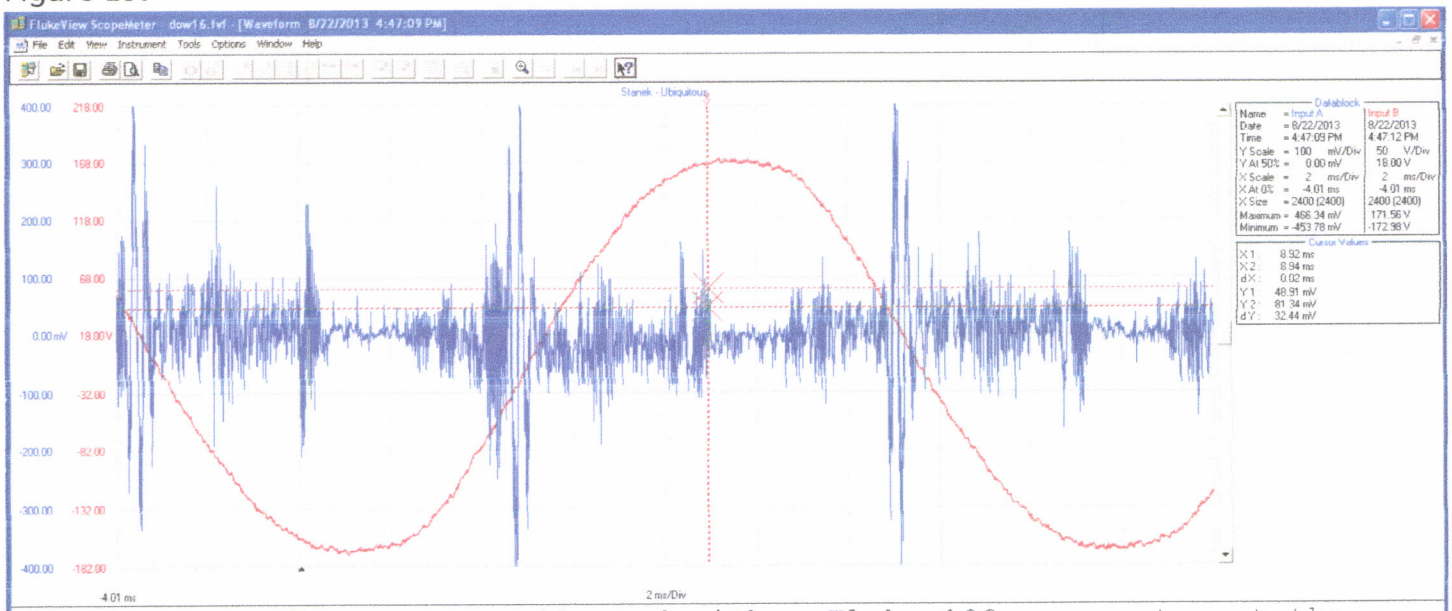
The above frequency spectrum is of a waveform collected between the kitchen sink and floor of the Jason Stanek home near Otho, IA. Energy above 1.7 kiloHertz (Cursor 2) will dissipate internal to the human body.

Figure 18.



The above waveforms were collected with a Fluke 199 scopemeter at the Jason Stanek home near Otho, IA. Channel A was connected to the 120 volt power supply. Channel B was connected at the same potential except through a Graham Ubiquitous filter (removes the 60 cycle). The area between the cursors represents a frequency of 50 kilo Hertz. Compact flourescent bulbs were off at the time.

Figure 19.



The above waveforms were collected with a Fluke 199 scopemeter at the Jason Stanek home near Otho, IA. Channel A was connected to the 120 volt power supply. Channel B was connected at the same potential except through a Graham Ubiquitous filter (removes the 60 cycle). The area between the cursors represents a frequency of 50 kilo Hertz. Compact flourescent bulbs were turned on at the time.

Summary

The data collected was the data present at the time of collection. It needs to be understood that these levels change with time and electrical usage. Very few wind turbines were in operation near Pomeroy, IA at the time of testing. Long-term monitoring should be done while the wind turbines are in operation and also when they are not in operation. The data should then be compared to determine what contributions (of high frequency transients and harmonics) are attributable to the turbines.

David Stetzer

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